



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

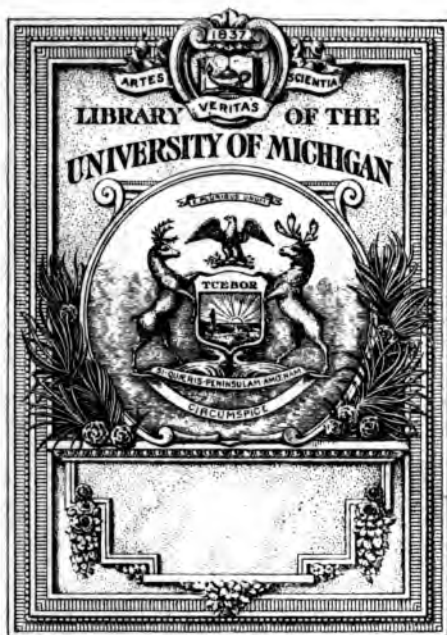
- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

A

813,716



B]
51
.M



Α ΣΚΕΤΣΗ
ΟΥ Α
ΦΙΛΟΣΟΦΙΑ.

Ἀριστοῦ καὶ Τίμαιου.

PLATON in Tim.

PART I.
MIND:
ITS
POWERS AND CAPACITIES,
AND ITS
RELATION TO MATTER.
PRICE 6s.

PART II.
MATTER
AND
MOLECULAR MORPHOLOGY:
THE ELEMENTAL SYNTHESIS.
ILLUSTRATED BY 75 DIAGRAMS OF MOLECULES IN THE TEXT.
PRICE 3s. 6d.

PART III.
THE CHEMISTRY
OF
NATURAL SUBSTANCES.
ILLUSTRATED BY TWO FOLDING PLATES, AND 150 FIGURATE DIAGRAMS OF
MOLECULES IN THE TEXT.
PRICE 7s.

(All three sold separately.)

LIBRARY OF THE
UNIVERSITY OF
EDINBURGH

A SKETCH
OF A
PHILOSOPHY
PART IV.
BIOLOGY AND THEODICY
A PRELUDE TO
THE BIOLOGY OF THE FUTURE.

ILLUSTRATED BY A PLATE AND DIAGRAMS IN THE TEXT.

BY
JOHN G. MACVICAR, M.A., LL.D., D.D.

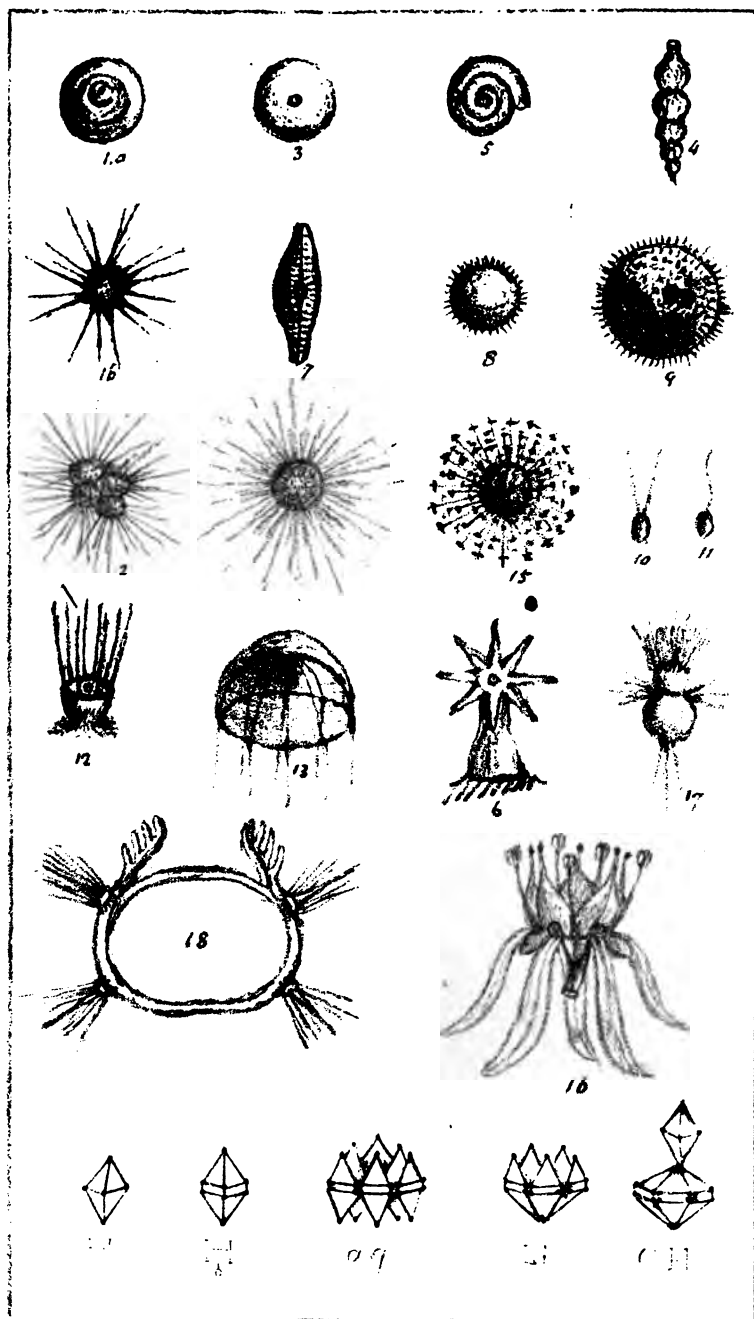


WILLIAMS & NORGATE;
6 HENRIETTA STREET, COVENT GARDEN, LONDON, AND
25 SOUTH FREDERICK STREET, EDINBURGH.

(274.)







12353



A SKETCH
OF A
PHILOSOPHY

PART IV.

BIOLOGY AND THEODICY

A PRELUDE TO

THE BIOLOGY OF THE FUTURE.

ILLUSTRATED BY A PLATE AND DIAGRAMS IN THE TEXT.

BY

JOHN G. ^{Macvicar}MACVICAR, M.A., LL.D., D.D.



WILLIAMS & NORGATE:

14 HENRIETTA STREET, COVENT GARDEN, LONDON, AND
20 SOUTH FREDERICK STREET, EDINBURGH.

1874.

PRINTED BY NEILL AND COMPANY, EDINBURGH.

PREFACE.

IN this concluding Part of "A Sketch of a Philosophy" (and in the preceding Parts no less), the views commonly held on the same subjects have scarcely ever been placed in contrast with those which are here advanced, or the evidence in favour of either balanced. Our philosophy has been presented to the reader mainly as a cycle of thought, arising out of an unity, given by consciousness as a reality, which developes into variety, and which as it flows is met in its course by Nature verifying it on all hands in actual phenomena. With these phenomena the reader is supposed to be well acquainted, so as to be able on his own suggestion to connect together our deduction or development with the corresponding phenomenon as a verification. For the author to have gone on verifying as he proceeded would have required many volumes, and such an interruption of investigation as would have made it impossible to accomplish what he believes that he has accomplished.

If it be asked what this is, the answer is, that the student of science by admitting three fundamental ideas—(1.) An Infinite and Perfect Being the fountain of all; (2.) finite Being, His creation, and as it were His shadow, given by His breath in space and time; and (3.) the Law of ASSIMILATION, the cosmical law, the sole law of nature, whether matter or spirit—the student in science—may save himself the time and trouble of acquiring a vast number of technicalities and formulæ, and much besides that commonly goes by the name of science, and proceed at once to explain in a manner satisfactory to himself, if he be free from bias due to antecedent training, the most part of what he reads about or observes around him—provided his observation or narrative be accurate, and in any measure proportional in quantity to the whole of what he proposes to explain.

And here the possibility of much saving and success may perhaps be made to appear probable even in a few words, by stating in immediate contrast the general features of the science of the day, so manifold and often so conflicting, with the few principles which are insisted on in this and in the three preceding Parts.

I. Instead of postulating many kinds of natural substances essentially different from each other, such as spirit, and æther, and matter of some sixty-three different kinds, each kind with its own essential properties, our philosophy postulates only one kind of finite substance, and that with no intrinsic properties at all, but finitude as to quantity, and self-manifesting power, that is, existence, using the term philologically.

II. Instead of attempting to explain the phenomena of the intellectual, the moral, and the material universe, on the supposition that the original ground of all is dead matter and force, or force alone so mechanically constituted, that its mode of action may be defined in a mathematical formula—a basis for investigation by which the highest and most important phenomena of all, those of intelligence namely, can be even recognised surreptitiously only, and can be accounted for in no degree, and are therefore naturally thrown into the background and disparaged, while yet they are plainly the most obtrusive of all phenomena, and indeed constitute that realm in which all philosophy and science, and in which alone any philosophy and science can be pursued—we open our lines in this very field of intelligence in which we find ourselves at first, and in the light of which we are inexorably required to view all things from first to last; and invoking from the depths of our own consciousness the affirmation of intelligence in perfection somewhere else than in ourselves, we posit as the first word and principle of our philosophy, a Perfect an Infinite Being, possessing without limitation or defect those attributes which our intellectual and moral nature mirrors in an imperfect degree. Thus finding that at the fountain-head all is life and reason, we escape the hopeless inquiry which is now agitated with such conflicting evidence and argument, as to where and how the living begins to appear among the dead, and why nature manifests reason everywhere.

III. Instead of a continually increasing crowd of so-called laws of nature, rational or empirical, it follows from what has been stated that but one law is to be expected for the whole universe; and this we maintain. For how could the finite substance of creation be actuated

otherwise than so as to embody and to body forth the will, that is, the activity of the being and attributes of the Creator, so far as the finite can embody and manifest the Infinite. The finite, considering that it lives and moves and has its being in the Infinite, which is Infinite Power, surely cannot but assimilate itself as far as possible to the Infinite, and manifest in itself His being and attributes. The mere substance of creation, viewed as apart from the Creator, must be wholly amorphous, so to speak, and passive—wholly plastic and assimilative. Hence the law and economy of the cosmos must be ASSIMILATION both subjective and objective.

Let it not be thought that if such be the only law both for spirit and body and all things, there must have resulted in creation universal sameness, long before the present epoch, if not from the very first. No; by assimilation to the Creative Will, *spirit* comes to be possessed of a measure of individualised power and liberty, which maintains variety and difference in the spiritual sphere; and *body*, having to exist in space and time, that is, in positions and moments presenting essential and endless differences, there results, along with a discoverable tendency to similarity everywhere, such a variety as nature actually displays, and the universe is, as we find it to be, a cosmos or harmony.

Of this cosmical law—the law of assimilation—some of the most immediate results are these:—

(a.) In virtue of the omnipresence and imminence everywhere along with unity everywhere of the Infinite, there result *in the finite mind* the two grand processes of distribution or analysis and association or synthesis by which all logical thought is at once developed and regulated (and that of course by the law of assimilation); and *in the finite substance generally* there arise the properties of divisibility and confluence.

(b.) In virtue of the spirit-nature of the Infinite, the first-born of creation is a world of spirits. And this world, for the reason assigned in the last paragraph, is a hierarchy, which, being first constituted in fulness of attribute, afterwards, under diffusive or analytic agency, descends, expands, and (being finite) attenuates, until, simulating omnipresence, it vanishes into the universal æther or realm of light, thus providing for its inhabitants a congenial dwelling-place and home.

(c.) But why, it may be asked, are not the elements of the finite substance, which is essentially spiritual, after having been attenuated into the ætherial, not confluent into monads possessing mental powers

again as fast as they are reduced to minima, so that an abode having been once provided in the realm of light for the world of spirits, the whole creation may consist of sentient beings only, and the sustained voice of the universe be universal enjoyment? To this the answer is, that in virtue of the self-assimilative, and therefore self-conservative, power of the ætherial elements, synthesis or aggregation can only take place by juxtaposition and not by confluence, until the nebular speck resulting has attained a certain bigness and pressure towards its centre. And when this bigness has been reached, and confluence in the centre does take place, the monad resulting is still too feeble to have recovered mental powers, and can only manifest such mechanical powers that, taken along with its generating atmosphere of æther, this new order of being, this new unity, constitutes the material element.

(d.) But though the immediate and direct birth of spirits out of æther or the matter of light in which the spirit-world dwells, be thus prevented by the genesis of matter instead, yet the restoration to the spirit-world of all the substance beyond, the overflow in æther, is not frustrated. The synthetic action which gives to nature the material element, goes on in the matter generated until a scaffolding (in our planet the myo-cerebral apparatus) is erected by which such a large and powerful volume of unified organised æther is upheld for years, that there is given by confluence in its focus of action a monad, constituted by such quantity and energy of substance or force (which are the same) that psychical, ultimately as in man, spirit-power is restored; in fine, there is a spirit adequate even to mirror the attributes of the Infinite, while the mode of its birth and education secures its being in harmony with the material economy, as long as the organism is its home.

Thus the created substance, after a lapse to a certain extent into matter, that is, into the apathetic and the dead, is raised to life or spirit again, and becomes capable of new enjoyments, in aspiring towards the ever-blessed One, the author of all.

Our philosophy thus retains all the facilities of materialism and pantheism in explaining phenomena, and contains within itself the theory of evolution. But it accuses these views of a want of extent co-ordinate with that of reality, and affirms that a philosophy adequate to satisfy reason must have as its first word an Infinite Omnipresent Intelligent Being.

ANALYTICAL CONTENTS.

CHAPTER I.

BIOLOGY IN ITS RELATION TO THEODICY.

	PAGE
Natural science as commonly cultivated at present is calculated to suppress the spirit of adoration, which is a great loss both to the enjoyment and the intellectual and moral culture of the student, . . .	1
The occasion for adoration is, however, stronger now than ever it has been before, inasmuch as the knowledge both of the mode of the creation and the admirable structures and functions and the harmonious correlations of natural objects, is more complete, . . .	2
This illustrated by the function of respiration viewed in the light of the recently revived doctrine of the conservation of energy, . . .	3
We are also in a condition now to solve many previously embarrassing questions, such as—the complication of organs needed for the assimilation of food in the most gifted animals, in man, for instance, compared with that in simple animals, as <i>Amœba</i> , &c.—the apparition of life in nature everywhere that its maintenance is possible, &c.—The popular controversy on this subject takes its rise in the mistake of biologists, who are always seeking the living among the dead, whereas at the fountain-head all is life—The Ever-living One, . . .	6

CHAPTER II.

THE PREVALENCE OF LIFE IN NATURE PAST AND PRESENT.

The naked eye gives no idea of the extent to which life exists in our planet. The microscope and the minute examination of the strata make it difficult to say where life may not still exist, or have existed in some former epoch. Not a drop of water can be found, unless quite recently distilled, but to the eye-sight when duly assisted, or to chemical reagents, it either shows actual life or else ammonia, which is usually held to bespeak antecedent life, . . .	10
The air also is found to be charged with living beings and things—ova and spores, it is said; but if so, why not the developed forms of spores and ova also, just as the sea contains fishes as well as their ova?	

	PAGE
Plainly such quick aerial beings could never be caught alive, and if caught at all, then only as shrivelled remains sure to be mistaken for ova or spores,	
Also the dark depths of the ocean are carpeted with living beings, often of exquisite forms and bright colours, these depths being no doubt lighted up by them in some measure,	11
Happily for science, many Protozoa have stony skeletons, which endure after life has departed even for unknown ages. And so abundant everywhere, and so deep down in the earth's crust, are their siliceous and calcareous skeletons found, and so decidedly and rapidly does geological discovery move in this direction, that it already suggests the thought whether the whole crust of the earth may not have originally been an excretion or secretion of life,	11
Such a conception is, indeed, incompatible with the popular chemical hypothesis that there are original inorganic as well as organic in-transformable elements. But that hypothesis, resting as it does on the supposition that the analytic and transmuting power of the chemist, in his little way and day, is as powerful as that of nature in her grand secular cosmical energy, cannot stand much longer,	12
But it is not incompatible with the nebular hypothesis. On the contrary, in keeping with the well-known very gradual course of nature when her proceedings are normal, condensation of the primæval vapour may have taken place so slowly, that the primæval temperature possibly should just have been that which was most congenial for the organisms to which existence was then to be awarded; while yet, after condensation had proceeded a certain length, the heat about the centre, resulting from the fall and the pressure, would be sufficient not only to forbid life there, but to fuse together and obliterate all traces of antecedent life in those regions, and leave stony matter only,	12
It is, however, also consistent with expectation, that mineral matter (that is, matter composed of molecules so stable as to be incapable of life) may have had a dry or meteoric origin from the first,	13
The vast extent of organisation in our world, and of its obliteration by metamorphic action, is here illustrated by ample quotations,	14
Vegetable life is not of so old a date as microscopic animal life,	20

CHAPTER III.

INDICATIONS OF A CERTAIN RECURRENT FORM (THE NAKED OR APPENDICULATED CELL) AND OF CERTAIN RECURRENT NUMBERS ($12 + 20 = 32$) IN LIVING BEINGS AND THEIR PARTS.

To the eye, when armed by the most powerful microscope, the mature forms of the lowest and simplest animals (Gregarina, Amœba, when in repose) appear quite similar to ova, though the latter, instead of being mature forms, develope into the most highly organised animals,	21
--	----

	PAGE
Hence the uselessness of the bodily eye for imparting a knowledge of structure, and the necessity of having recourse to the mind's eye, the interpreting power, reason. But ocular vision, when rightly interpreted, gives a just idea of external form,	22
The form in the simplest organisms, when they are at rest or imprisoned but not pressed upon, tends to be spherical or cellular, and usually contain a nucleus, often a nucleolus, but without appendages.	
When organisms are active, or exist free in a congenial medium, they tend to depart from the spherical in form, and usually have appendages, cilia, pseudopodia, tentacula, &c., as in spores, Actynophrys sol, &c.,	23
When their weight, or the attraction of the walls of the containing medium, leads to their fixation, then instead of the spherical there is given only the hemispherical, a cup or saucer shape with appendages around the rim, as in Hydra-tuba, Polypes, &c.,	24
But living matter soon gives dead, that is, stable or untransformable, that is, mineral matter, silica, lime, &c. By this the forms of animals otherwise too soft to have more than an ephemeral or microscopic existence are supported, so that the species, especially in a community, may become lasting and large (Rhizopoda, corals, &c.),	25
Since the accumulation of dead or mineral matter thus produced by life must, in the course of the all but infinite ages during which our planet has existed (itself one of the sphere-affecting forms of nature), be inconceivably immense, may it not be argued that, like its offspring, the primæval deep too has come in this way to acquire a concrete shell or crust? An Orbis terrarum like the Orbulina universa!	26
In the march of scientific knowledge the seemingly ridiculous is often the prelude of general acceptance and admiration. (Antipodes how ridiculous! The sun the centre of the system, how ridiculous!)	
Molecular synthesis has a tendency to give not only a typical form but typical numbers of parts or organs in that form.	
The law of action and reaction in systems composed of perfectly elastic elements tends to develop their corresponding parts in sets of 4, 8, and the doubles of the same series; around a centre as in tetraspores, coral polype, &c., or around an axis, as in most crystals,	30
But this does not account for the selection which nature makes of certain of these multiples to the neglect of others. Of these the most prevalent when the development is complete is 32. Thus among the feet of nature, peristomes of mosses, Hypnum, Bryum, &c. At the head of nature, in man, the teeth, the cerebro-spinal or knotted nerves (including the 5th), &c. Extensive observation shows that this number is not simply one of the series 4, 8, &c., but is the sum of $5 \times 4 = 20$ and 12. This is illustrated by reference to the numbers of milk and permanent teeth in man, &c., of articulations in the axis, of limbs, and bones in the limbs of animals, and of parts in the fructification and general structure of plants,	31

	PAGE
But the utter distaste of the naturalists and chemists of the present moment for such enquiries dissuades from lengthened statements,	32

CHAPTER IV.

THE THEORY OF DEVELOPMENT. ITS DEFECTS. THE CONDITIONS OF ITS
COMPLETENESS.

Design often appears at once in nature, and that beneficent. But sometimes design does not appear, and where it does it seems cruel. Such an aspect of nature is embarrassing to reason, and painful,	33
The institution of the spherical as the hybernating form for an organism or morsel of delicate substance, which needs protection in the midst of its environments, and which is also to be capable of a full play of form and deployment of life when its environments are not dangerous to it, is manifestly a most wise and benignant design,	34
But no reason appears with regard to organisms for the selection of those numbers which have been indicated ($12 + 20 = 32$) in preference to others which are as frequently employed in human art,	34
Often also when design appears, it seems cruel, as in carnivora, parasites, entozoa, zymotic spores and ova, &c. Hence many thinking men are at the present moment in a state of bewilderment as to the origination of nature, many affirm entire nescience,	35
In this respect the theory of development may be regarded as a modern and a scientific substitute for the ancient theological conception of a Demiurgos, as such is of value, and when true to its name and fully developed, gives a pure theism both as its first and its last word,	35
But this theory as at present advocated, when viewed in reference to the whole of its sphere, contradicts itself, and breaks down midway between its termini. It proposes to trace all organic species to one primal organism, but that organism it admits to be constructed by the use of some 20 chemical species, which are held to be essentially dissimilar and intransmutable from the beginning and for ever!	36
This theory, as a complete system of thought, applicable to its whole sphere, implies that in the first or last analysis, at the origination or complete dissolution of nature, there was or will be only one species of matter, not some 64, as the chemistry of the present day maintains,	37
Moreover, beyond the world of matter there is the universal æther. It belongs to the theory of development to hold that the material element is a development or synthetic product of the ætherial,	38
Nor this only. Reason cannot rest in regarding the æther (a medium consisting in a multitude of separate particles devoid of all vision and power of designing) as the first of all beings and things. Of the theory of the development of living beings, when logically and scientifically carried out, the first term can only be a living Being who is One, and who is adequate to design the universe—in a word, God,	38

CHAPTER V.

THE TRUE PROTOPLASM AND THE COSMICAL LAW.

- The objection to belief in a creation by an Infinite Being, on the ground of His pre-existing fulness, and the fact that a creation cannot but be finite, and therefore imperfect, vanishes when we consider the nature of that to which alone existence owes all its value—namely, happiness. For where one only exists, one only can be happy; while by awarding existence to a creation, countless millions may, 38
- This theory of creation leads to the inference that the primal substance of creation shall be a protoplasm—a pure or simple living substance wholly plastic in itself, or, in other words, assimilative in the highest degree to the being and attributes of the Creator, the Ever-living and the Ever-blessed One, 40
- Hence a cosmical law—namely, the law of assimilation in its three branches: viz., assimilation—(1.) to the Divine attributes; reason; (2.) each individualised object to itself, both as to space and time, giving form and structure, elasticity and heredity; and (3.) all to one another; homology, implying occasionally uselessness, 41
- By an appeal to this law alone it is affirmed that all the phenomena of the creation are to be explained. Hence in nature generally, permanence of property in a properly individualised object,—that is, successive assimilation to self as it was at first, implying also *Permanence of Species*. Hence, *species in genera*, that is, the reciprocal assimilation of kindred or influentially assimilative species; and hence, ultimately, *the general harmony of nature*, that is, the assimilative influence of each on all, and of all on each, 42
- Hence in the spiritual world, *Perception*, which is assimilation of a percipient as such to the object presenting. *Remembrance*, which is the assimilation of the present to some former state of self. *Reasoning*, which is remembrance of assimilated ideas with exclusion of dissimilar or irrelative ideas. *Imagining*, which is remembering in fragments and at random, or selecting with a view to some other object than the representation of reality. *Judging*, which is the assimilating self with ideas which are held to have been assimilated to one another. *Idea*, which is the product of the act of mental assimilation. And so on with all our faculties or modes of mental action except *Liberty*, which is the mind as an agent assimilating itself to the Creator Himself as the Supreme Will, 43
- Hence in the physical sphere, *Attraction*, which is the assimilative action of atoms or masses as to the place they occupy—a theory which also gives the law of the inverse square of the distance. *Elasticity*, which is the assimilative action of a form which has been disturbed to its previous form. *Heredity*, which is a secular elasticity, or assimilative action in successive individuals of the same series. *Symmetry, culminating in sphericity or symmetrical cellularity*, which is the assimilation

	PAGE
of all the parts or particles of a form to some one plane or line, ultimately some one point within that form. <i>Chemical and Electrical Action</i> , which is the assimilation of dissimilars by union when it is permitted, and the nîsus at it by assimilative currents of force passing between the dissimilars where union is prevented. And here the theory of voltaic action is given in detail,	47
By the same law is to be explained <i>the differentiation</i> of organisms in proportion as they are to be preserved long as concretes, in media and under influences tending to assimilate or dissolve them ; as, for instance, a tender embryo which has to resist the solvent action of the aqueous medium in which it lies for long, and afterwards to remain concrete in air for years, perhaps under very varying temperatures, &c.,	53

CHAPTER VI.

THE CHARACTERISTIC OF EXISTENCE IS SELF-MANIFESTING POWER.

Though our philosophy admits only one kind of created substance and one cosmical law, yet that law acts between two limits or poles, and by two modes which are the opposites of each other. Hence nature is a web in which unity and multiplicity, identity and difference, are everywhere interwoven, so that while the variety is all but infinite, all is harmony and beauty,	54
The essential characteristic of existence is that which the term implies—standing-out-ness or self-manifesting power,	54
As to the distance from its centre or its visible parts to which an object can manifest itself, no limits in space can be discovered. But intervening matter intercepts the self-manifesting power of more remote objects and eclipses them, as the iron of an iron ship intercepts the magnetic action of the terrestrial poles to a needle in the ship's hold,	55
As all objects exist in the æther as their ambient medium, they assimilate it around them more or less to themselves. And where there is dissimilarity between objects (which has been shown to be the condition of energetic reciprocal action), as between a luminous object and a dark object, a planet or any illuminated object, for instance, and a choroid or eye, this assimilative action may be continued in ætherial rays to incalculable distances, as between the stars and the eye,	56
But as the æther must act according to the laws of inertia or mechanical motion, the forms of external objects can only be given to the eye in projection. The true perception of them, proper to their own self-manifesting power, can only be made out by clearing off the perspective which is mechanically imposed in them. This, man cannot do, in consequence of his helplessness at birth and long after, but by a tedious though unconscious process. But animals whose organism functions perfectly at once see objects as they really are, and where they really are, almost the first time they look towards them,	56

Perception has its normal focus in the brain. But it claims as its domain the whole organism, and it is impossible to say to what extent beyond the organism the mind whose centre of force is within may not act or influence. The same is true of every elemental force or atom when viewed in reference to its centre or palpable region. The range of its action is not discoverable,	PAGE 57
"Substance" is not essentially distinct from "force" or "power." Still there is good ground for the use of all the terms. Almost all objects are capable of existing in either of two modes—the dynamical and the statical. When regarded as dynamical, they are called forces or powers. When regarded as statical, they are called substances,	58

CHAPTER VII.

A WORLD OF SPIRITS AND THE REALM OF LIGHT.

Where an individualised unity of power or substance is a monad of such energy that is self-manifesting to itself, it is a percipient or intellectual being or spirit,	59
The immensity of the Creator, the Ever-living One, on the one hand, and His unity on the other, indicate as His most immediate creation a world of spirits, and that as a hierarchy, at the top of which are spirits of the highest order, and at the base such as are only capable of enjoyment, and no other feeling, save the possibility of pain, as the opposite pole the relish and safeguard of enjoyment,	61
But if the cosmical law is to be allowed to take full possession of the created substance, and is to assimilate it as far as possible to the immensity as well as to the unity of the Creator ; then, since its quantity is finite, partitionment of substance and consequently the attenuation of the individual must be carried out, till all space is occupied with existence as far as possible, and each individualised element comes to be next to nothing. The elements now cannot, therefore, individually be spirits or percipients. Yet, since they are most near to the All-seeing One, what we are to expect of them is that they shall constitute a medium by which perception shall be facilitated ? And thus after a world of spirits and as their home, our theory gives the realm of light, the ætherial medium,	63

CHAPTER VIII.

THE MATERIAL ELEMENT : ITS GENESIS AND STRUCTURE, AND ITS NORMAL MODE OF ACTION.

Time, as the condition of our consciousness, obliges us to think of things in a thread or successively. To the Creator all is simultaneous and from eternity, as well as successive. Hence, in order to imitate the Divine procedure, after completing a development, we

	PAGE
ought to reverse it, making the last first. After analysis, synthesis, and <i>v. v.</i> ,	65
By synthesis of ætherial elements around different centres nebular specks result, in which, by virtue of the centrad pressure, the innermost set of ætherial elements become confluent into monadic nuclei, thus giving to nature a new order of being,	66
Geometrical considerations lead us to suppose that the numbers in the interior of the nebulous speck which will thus become confluent will be 12, with 20 overlying them, in all 32, or <i>v. v.</i> , giving as lines of mutual pressure previous to confluence the dodecahedron and the icosahedron, the one circumscribing the other,	67
To discover the exact number of ætherial elements in each material element is hopeless. But to find the mode of action in these elements in the ætherial atmosphere which correspond to the structure of the now unified nucleus is not so hopeless, and is much more important,	70
To this the cosmical law, ever aiming at the assimilation of dissimilars, guides us. And as to the normal mode of action that will be established, it is illustrated by the experiment of the electric spider,	71
If the material element thus in action, when in a free medium, such as water, could be rendered visible by the microscope, it would be taken for an ovum or spore surrounded by vibrating cilia. When in an imprisoned state, or as a member in a tissue where the cilia could not be or play, it would be taken for a nucleated cell,	72
Further investigation shows that, according as the external resistance is equal all round or less in some directions than others, two orders of forms must result, the former condition giving spheroidal forms resembling ova, the latter giving (by partitionment) spiral or caudate forms resembling spermatozoa or antheridia, always wriggling in the endeavour to wind themselves up and regain the spherical,	73
Hence the development of ova after impregnation becomes possible. The spherical, symmetrically constituted within, is the form of repose, and cannot develope. This structure impregnation disturbs by the insertion into the ovum of a merely axial body in want of and demanding equatorial parts and sphericity, for such is the spermatozoon,	73
The cosmical law, when the walls of the containing medium are dissimilar to the organism in it, causes the ovum or spore to tend to settle or become fixed, as hydrozoon, sponge, alga,	73
It can now no longer attain to the spherical. But it never ceases to aim at it, and hence it buds and buds. And when it has secured an attachment to a point standing up in the liquid, the composite organism sometimes attains a great degree of sphericity. But as it more usually forms on a flat surface it is hemispherical only,	73
The nîsus at the spherical in time when it fails in space gives also the phenomenon which has been called "alternate generation,"	73

CHAPTER IX.

OF ELEMENTAL RESPIRATION AND EXHAUSTION.

- The normal mode of sustained action in the ætherial atmosphere or dynamisphere of the material element, according to the relative state of the medium beyond, must produce either of two states,—one in which there is no loss of material substance, and which is represented in visible nature by the ovular, encysted, or hybernating state of organisms ; the other in which there is active life and continual loss of material substance, in respiration, &c., 76
- But the cosmical law always implies reciprocity. All material elements, in continually giving off to the region above and beyond, by the excursions of the elements of their ætherial atmosphere, a material aura, which their nuclei accordingly lose, receive in return for this dead effluence a new supply of vital energy from that which alone is beyond and above,—namely, The Ever-living One, the alone source of all the energy of the universe, 76
- But though the Supreme Mind and Will is thus imminent to all nature, nothing calculated to disturb the amount of energy proper to the material nature ever occurs, 76
- The perfection of His intelligence and insight into all things from eternity to eternity forbids mistakes and the need of corrections ; so that when the conditions of existence are the same, so are the phenomena constant and uniform. Moral conditions (such as rational prayer, need for miracle) no less than physical, are accompanied by their appropriate phenomena (that is, an answer, a miracle), they are inwoven with the relative material conditions, 78
- The outward and inward movements of the ætherial elements in the atmosphere of the material element prelude respiration in organisms ; during which, moreover, the inspired oxygen of the air represents the ætherial elements when descending upon the nucleus in the material element ; in which latter the nucleus represents carbon, 79
- Respiration is the most fundamental of all organic functions. It is the perpetuation all down the stream of being of the mode of supplying at the fountain-head continually renewed vital energy. In the relation between Creator and creation it is most probably inevitable, at least under cosmical law as it actually exists. But the loss of substance in the individual which respiration implies demands that the animal kingdom in its beginning shall be such that the stronger organisms, in order to exist, must destroy the weaker,—an economy at first necessitated, and carried up till we reach the Carnivora, 79
- But this unavoidable evil has been reduced to a minimum since the destination of the products of respiration is to give birth and increase to the vegetable kingdom, and thus to produce structures which are incapable of suffering, and yet every way suited to store up for respiration, food for repairing its own waste, 80

	PAGE
The material element itself, with its actual structure as here conceived, is of the nature of a necessity, rather a foreseen and a divinely regulated thing, than a freely willed and primary creation, and as compared with a world of spirits, only as a cloud in the azure—beautiful, indeed, and capable of becoming the mother and nurse of spirits, and therefore sanctioned, but wholly incapable of thought and enjoyment in itself, and wholly unaccountable if viewed as the whole of creation, .	81
It appears that a world of finite spirits alone could not exist without a material accompaniment. Existence implies all its conditions. Objects which are to occupy limited portions of space must possess forms and be subject to the laws of form, that is, geometry. Hence a liability to suffering becomes certain; for with space sensibility has no dealings. Its condition is time. And when attached to complicated structures in space, whose well-being requires the observance of many laws, sensibility in its reckless hunt for happiness violates these laws, and so causes and feels pain,	81
All which, on such slight views as have hitherto been taken of these phenomena, has seemed inconsistent with the idea of a beneficent Creator. And as many ancients were led to ascribe the world to a Demiurgos, so have many moderns been content to adopt the theory of Topsy in "Uncle Tom's Cabin," that existence was never divinely awarded to creatures, thus liable to suffering themselves and to cause suffering in others, but that they merely "grewed,"	81

CHAPTER X.

OF ALIMENTATION: ITS MODES, AND ITS UNAVOIDABLE LIMITS.

The material element itself, compared with all its molecular combinations, is very stable and lasting. But if it has been generated out of ætherial elements as its ancestry, it must, under the law of assimilation (reversion), be liable to be resolved into æther, the matter of light again, most probably with some degree of luminousness, in the region where the solution or explosion of matter into æther is taking place. But, under the same law, those ætherial elements which previously constituted material elements will tend to do so again. And thus the periodicity, the cyclical character of nature is instituted in the very structure and nature of the material element itself,	82
It is the heavenly function of respiration itself which gives a beginning, and institutes that system of alimentation which at first sight, and in its most striking feature, is deemed so objectionable and contrary to what were to be expected in the creation of a benevolent Being. Thus, since respiration implies exhaustion, it follows that breathers of the same kinds, according as they have breathed or lived more or less, are weaker or stronger. They are therefore dissimilar, and union will tend to take place between them. This phenomenon, when viewed in reference to the whole of nature and of the function, may take place	

	PAGE
in either of three ways. It may be—(1.) transient (sexual union); (2.) attachment (combination, differentiation, new species); (3.) absorption and assimilation (food commonly so called),	83
In order that animals may breathe freely, live, and enjoy their lives, food must be had; and since the genesis of vegetable matter is normally posterior to animal matter, the liability of the weaker animals to become the food of the stronger is unavoidable,	84
A perfect economy of alimentation, considered purely as such, admits the use of animal food only, for in this kind of food alone there may possibly be no rejectamenta, no refuse,	84
Also animals are strangers to all painful presentiment of death; and the violent modes of their seizure when they are about to become food for other animals, seem usually to produce anæsthesia, and to seclude them from suffering,	84
To increase the quantity of vegetable food, the continuous expiration of the volcano, and the more secret action of the abyss, have been appointed to second the respiration of the animal kingdom. And to increase to the utmost the quantity of food of both kinds, the utmost fecundity has been instituted both in plants and animals, which also secures a maximum of enjoyment in the latter, for the sake of which alone they could value life, which it is witnessed that they do upon the whole, by the general struggle for existence,	85
This struggle, when expressed in its most general terms, is between the leaf and the lung—a friendly struggle, in which the defeat of one is in reality the signal victory of both, the leaf (the vegetable kingdom) in yielding itself up to the lung (the animal kingdom) affording the latter “bed and board, coal and candle;” then, phoenix-like, speedily, after having been thus utilised, arising again from its own ashes as fully alive as before, carpeting the planet anew with beautiful foliage and flowers, fresh food for animals again,	86
A liability to pain is possibly implied in a capacity for enjoyment. At any rate, it is the most effective safeguard of the integrity of the organism. That it should continue after a fatal lesion, is in keeping with the operation in all cases of general laws,	89
As for death—supposing an internally reposing organism to be constructed in all its perfection at once, and placed in a wholly congenial situation, in which all its wants were steadily supplied, it would not be liable to death. The cosmical law (assimilation to self in every successive moment) would only act to preserve it as it is, like a perfectly elastic thing or mass, having a constant amount of inertia. It is birth and growth which carry in them the sentence of death. In that case the cosmical law, acting as a law of reversion, obliges the organism when it culminated in the ancestral type to live over again its life backward, and so to decay and die, that is, to dissolve into aeriform and earth particles again, and thus give itself again to nature on the grand scale,	90

CHAPTER XI.

OF REPRODUCTION AND SEX.

- Reproduction, that is, multiplication along with assimilation to what existed previously, is not confined, as is usually supposed, to organic beings, plants, and animals ; there is all through nature the same, or a *nisus* at it. In a saturated solution, when a single crystal is introduced, a brood of crystals soon appears, or when liquid is poured in, solution of crystals follows, 91
- When healthy plasma fills an open wound in the solids, it is soon assimilated, solid is reproduced, and the wound healed. On the other hand, unhealthy liquid assimilates the solid walls of a wound or liquifies them, and ulceration takes place, 92
- In effecting assimilation to pre-existing specific forms or structures, the cosmical law never forgets the type of all forms, namely, the spherical and cellular. Hence normal growth is always by the addition of cells. This energy may be such as to give first solid not cellular spheres almost all round (buds) or all round (seeds, ova). The motive to their development is a *nisus* at the cellular by protruding their contents. But the vital action, taking place along one axis, causes departure from the spherical, and gives axial forms. Hence segmentation, *striæ*, *septa*, *nodes*, &c. (see ova, muscular fibres, *confervoidæ*, plant axes, &c.), . . . 93
- The fecundity of species is secured or insisted upon in virtue of the cosmical law and the analogy of all nature. The structure of the material element itself precludes an organism which, having lived its day and done its work, gives birth to four or twelve, or it may be twenty, ultimately thirty-two young ones, 94
- The imperfection of the individual for the reproductive function implied in the fact of sex probably arises from this, that in the structure of the material element either the group of twelve or that of twenty ætherial elements in the nucleus may be in the interior, and that both cannot be equidistant from the centre, except on condition of the material element vaporising, or exploding, or escaping into the ætherial again. In the *nisus* at this structure, in which sphericity and cellularity culminate, adjacent groups of material elements will tend to possess, the one the one, the other the other, situation. Hence, being so far dissimilar, they will tend to unite, and each to abolish the difference of the other. Hence two results may be expected, (1.) a product from both, a resultant body, which at first shall be devoid of the difference (sex) ; and (2.) obliteration, functionally and perhaps even to the eye in some measure organically, of sex in advance age, . . . 97

CHAPTER XII.

VEGETABLE MORPHOLOGY : ITS GENERAL PRINCIPLES.

- The relation between the animal and the vegetable kingdoms, considered as one economic whole, leads us to expect that the animal form shall

be as compact as is compatible with adequate means of locomotion, while the vegetable kingdom shall be (1.) expanded or laminated in the air to the utmost, exposing the largest possible surface in order to decompose the products of animal respiration (carbonic acid), and thus be suited to supply fresh food (oxygen gas) for the lungs of animals, and (2.) not be too tough for the teeth of animals, but such as to be fit to supply food for their stomachs,	99
The ideal of the plant-form is still the same as that of every naturally individualised object, viz., the hollow sphere. In all but microscopic and imperfect or short-lived plants, this is aimed at by the development of a system of peripheral tiling or foliage, supported by slender leaf-stalks or branches in the air and by rootlets and roots in the earth, both systems radiating from a centre or axis, hence trees, &c.,	101
The physical agency in giving the vegetable kingdom to nature is, as always, the law of assimilation. Its first operation is as the law of reciprocal assimilation as to space, causing the air particles to descend into the earth, and the earth particles to tend into the air. Its second operation is as a law of assimilation as to state, the air particles becoming concrete as vegetable tissue, and the earth particles becoming as aerial as their nature admits by being carried up and located in the highest and most expanded parts of plants (giving ashes),	107

CHAPTER XIII.

THE FORM AND STRUCTURE OF A FLOWERING PLANT AND A FLOWER ARE
PRELUDED BY THE STRUCTURE OF THE MATERIAL ELEMENT.

The simplest stable organism or plant conceivable must consist of at least three material elements, the middle member being dissimilar to the two terminal members, as, for instance, having the twenty ætherial constituents central, while the terminal elements have the twelve,	120
In this chapter it is shown that the observed parts of plants and flowers, as to sex, situation, and number, are striking verifications of our theory as to the structure of the material element,	121

CHAPTER XIV.

THE SIMPLEST ZOIC FORMS AND FUNCTIONS ARE PRELUDED BY THE
STRUCTURE AND ACTION OF THE MATERIAL ELEMENT.

In the actual state of natural science, the forms and structures of the simplest organisms, whether microscopic or large, and whether animals or plants, are a perfect mystery to intelligence, nay, seemingly absurd. And naturalists are at present in a state of despair ever to be able to understand them or account for them, or do more than merely to observe and classify them,	126
The unity of the cosmical law securing harmony, nay, a certain homology	

	PAGE
all through nature, although the smallest object that is visible be as it were at all but an infinite distance from the single material element, explains these forms and structures, for they are precluded in the form and structure of the material element itself,	130
The simplest organisms, whether imprisoned (Gregarinida) or free (Rhizopoda), when reposing or hybernating, are spherical with some kind of atmosphere around them, and when active depart from the spherical, the free sorts sending out from their bodies processes and retracting them again, or surrounded by vibrating cilia, so as to simulate to a remarkable degree the action of the ætherial elements in the atmosphere of the material element, still more clearly seen in spores and ova and fully-developed organisms, such as the sun-animalcule, Volvox, &c.,	131
By considering the structure which must result from the union of two material elements, one of which has lived or breathed longer than the other, there is obtained a structure which preludes and explains the existence in animals of a head and body, the former furnished with a feeding apparatus, tentacles, teeth, &c., the latter with a breeding apparatus, a respiratory apparatus originally coming in between. (Many Infusoria, Polyzoa, Cephalopoda, &c.),	132
Three such coupled elements may unite by both ends. There then results a new type, consisting of six members in a circular system. But these will tend under the cosmical law to apply themselves to each other on the same axis, thus precluding Annuloidea, Annulosa, Vertebrata,	133
Three single and similar, as well as three coupled and differentiated material elements, may unite into a closed system. And when this is the case, the law of the spherical leads us to expect that a fourth will immediately apply itself symmetrically to the other three, and thus there will be constructed a body possessing a tetrahedral nucleus invested by a spherical atmosphere or dynamisphere so stable that it can neither be decomposed nor transformed. But to be thus is to be dead. Here then, very early in the operation of the cosmical law, we find the dead appearing among the living, and the true protoplasm undergoing a most notable differentiation,	135

CHAPTER XV.

ON THE DIFFERENTIATION OF THE PROTOPLASM TREATED OF IN THIS WORK, AND THE DEVELOPMENT IN IT OF THE ORGANIC ELEMENTS COMMONLY SO CALLED.

Recapitulation of biological principles till the first differentiation of the primal protoplasm and the first dead element, the tetrad, is reached,	136
Simple groups of three elemental forces or material elements tend to receive one atom more on each pole, giving a molecular structure of maximum stability, whose atomic weight is $3 + 2 = 5$, its symbol H.	

Also two tetrads tend to unite by their bases, giving a structure isomorphous with H, though differing in the structure of its equator, whose atomic weight is $4 + 4 = 8$, its symbol Hf . This, being dissimilar to the former, will tend to unite with it; and as the atomicity or number of points suitable for union in H is 5, the saturated product of union must be HH_5 , its atomic weight $5 + (5 \times 8) = 45$, <i>i.e.</i> , 9, when $\text{H} = 1$. Now, this is well known to be the relative specific gravities of common vapour and hydrogen gas. When the conditions of existence are incompatible with aq., and the atom of H is required to leave its situation, the five atoms of Hf close up into a most remarkable structure, which explains all the phenomena of oxygen and <i>oxygen gas</i> , an unit of the latter determined by the cosmical law being a coupled atom of <i>oxygen</i> , its atomic weight being $2(5 \times 8) = 80$, <i>i.e.</i> 16, when $\text{H} = 1$, which is the well-known specific gravity of oxygen gas as compared with hydrogen as unity, .	140
After the genesis of aqueous matter (oxygen and hydrogen, and, in certain cases, sulphur, being products of its decomposition) in the progress of the differentiation of the primæval protoplasm, ammonia or double vapour presents itself, yielding in decomposition azote (instead of oxygen) along with hydrogen, .	159
Azote by an easy transformation gives hydro-carbon, $2 \text{Az} = \text{C}_4\text{H}_4$, .	163
Then follows the genesis of silicium, calcium, and phosphorus.	

CHAPTER XVI.

ON THE ULTIMATE PRODUCT OF ÆTHERIAL AND MATERIAL ACTION.

Material action culminates in our planet in effecting cerebration, .	173
A cerebral unit is an individualized volume of æther centralized and supported by a scaffolding of light atoms very openly organised, .	174
As the nebular speck in celestial space by the simultaneous confluence of a certain small quantity of æther in its centre gives a monad, which is the material element, so the large volume of organised æther in the head, by the successive confluence of a large quantity of æther in its centre of action gives a monad of vastly greater power, viz., a soul—that is, a spirit whose mother and nurse and educator is matter, and an agent in which, in virtue of the great quantity of Being or force in it, mental powers, the proper end and aim of created substance, are restored. Instead of attraction and repulsion merely, along with inertia and elasticity, as there are in the material element, there are desire, and aversion, conscious self-preservation, &c. Thus the cycle of creation is completed by its return into spirit, in and out of which it took its rise, .	175

POSTSCRIPT.

This sketch of a Philosophy is now brought to a close, and that not without pleasing prospects as to the future of Science. Since 1868, when PART II., which related to molecular construction, was printed in Germany, there has been a notable progress of philosophy in the same direction. The spectrum-analysis of star-light emanating from sources differing greatly as to the degree of heat which actuates them, or the state of diffusion and attenuation in the matter of which they consist, has forced on the minds of chemists the very reasonable suspicion that cosmical force, acting out in the great universe since the beginning of time on the same particles of matter, may be capable of doing something more in the way of ultimate analysis than the chemist in his laboratory with his small experiments. In consideration of the growing simplicity which seems to characterise the light-giving elements of different heavenly bodies according as they are on the way to greater attenuation through heat or are already extremely attenuated, the idea begins to be tolerated even by experimental chemists, that of the 63 so-called simple substances only a very few, perhaps only one, can survive without decomposition that ordeal of molecular transformation which is the very secret of all the variety, the harmony, the beauty of nature.

On comparing the data of the spectroscopy with our molecular synthesis, it will be seen that those substances which ocular vision gives the astronomer as the last survivors under extreme cosmical analysis are the same as those which mental vision has given us under our method as the most simple, stable, and recurrent of molecular structures, viz., two lighter than hydrogen, hydrogen, nitrogen or azote (which in our theory is secularly resolvable into hydro-carbon ; $2 \text{ Az} = \text{C}_4\text{H}_4 = \text{olefiant gas}$), magnesium, sodium, iron, &c.

Chemists are still indeed content with their formless, structureless, phantom-atoms, instead of particles looking like reality, having distinctly conceived forms and structures ; they are content with mere abstractions, such as atomicity and affinity, instead of well-understood reasons and mechanical causes ! But surely chemistry as it now exists must soon become tired of itself. Surely it cannot be long before earnest minds who have youth and energy will make a rush into the light. As to others, it must not be forgotten that death usually supervenes before even demonstration can wholly change a long-cherished habit of thought. It was more than a generation—upwards of 30 years—after the publication of “The Principia,” before the philosophy of Newton was presented to the University of Cambridge, and even then by stealth, under the protection of the philosophy of Des Cartes, which was still taught ! Moreover, the perpetual secretary of The Academy of Science in Paris, living in scientific communication with all the world, 58 years a member of that academy and its historian, a man of genius, and an admirer of Newton, 70 years after the publication of “The Principia,” still maintained the Cartesian astronomy, and died in that belief, though he lived to his hundredth year ! Happy the man who by his own researches has been able to satisfy the demands of his own reason and to make silence in his own heart.

CHAPTER I.

BIOLOGY : ITS RELATION TO THEODICY.

A VERY remarkable change has in these modern times come over the study of nature. Formerly, nature used to be regarded chiefly in a contemplative point of view. Its grandest and most striking objects and arrangements were alone observed ; and as in them either beauty or utility, or both, were conspicuous, the thoughts of the beholder naturally turned to the Author of nature, and tended to close in a spirit of adoration.

But now all this is changed. The characteristic of our times is minute research. To see all that can be seen about some one individual object in hand as also about those which are most nearly allied to it, an accurate comparative crystallography or chemistry or anatomy of the object in the successive stages of its existence, and that specially, nay merely, in order to be able to classify it or to assign to it its "place in nature," is at present the main aim of the naturalist.

And, in this minute research so much is encountered that seems at first sight to ignore, nay, to conflict with the useful and the beneficial, that contemplation, when it is ventured upon, is often felt to be rather painful than agreeable ; and many naturalists of high intellectual powers, and not of an irreverent turn of mind, have given up adoration as an untenable position, and even orthodox divines have maintained that it is only from revelation, and not from nature, that any true knowledge of the Deity can be obtained.

Now, viewing this change in its general bearing, both on the man of science and on society at large, unless there be some great gain to balance it, plainly there is great loss. Yes ; setting aside all other considerations but that of personal enjoyment merely, and on the most restricted view that has ever been taken as to that which really exists,—adopting as to this matter, for instance, what the fashionable method of investiga-

tion logically leads to (which has been happily stated, without reserve, by J. S. Mills, in his criticism of Sir William Hamilton's philosophy), namely, that all we are certain of by way of external universe, is "a possibility of sensations," and by way of soul or mind, "a thread of consciousness aware of itself;" even supposing this to be all, still it remains true that the old contemplative way of viewing nature in the spontaneous and uncritical light of common sense had much in its favour which is lost in this new way. For of all "threads of consciousness," certainly there is none that is at once so delightful and so ennobling as adoration when there is seen by the contemplative mind to be a just occasion for it; and if, taking a larger view, we admit (what always has been, and still is, generally believed) that man, along with a regard to his own present enjoyments, has certain duties to the Author of his being, on the right discharge of which his true happiness, both here and hereafter, mainly depends, then, for him to live a stranger to adoration, which is manifestly the first of these duties, can be no light matter.

But it will be said, and said justly, that the teaching of the truth must be submitted to, whatever it may be—that the truth must be followed whithersoever it may lead. If the minute and accurate study of nature, it will be said, fails to suggest, and especially if it forbid the suggestion of an object of adoration, then we must exclude from our study such an object, and, of course, the emotion also which is appropriate to it, whatever the disadvantages. At any rate, we must look for the evidence for the existence of an object of adoration somewhere else than in nature. Now, let all this be admitted. But it has not come to this, nor anything like this. It may be shown, and shown most satisfactorily, viewing nature, both on its grandest scale and in all its details, that there is nothing in it to contradict, but everything to countenance and support that world-old view which regards nature as the creation of an infinitely perfect and powerful Being; only, to be able to co-ordinate nature with this view requires something more than the quick eye and the lithe fingers which are alone demanded by minute anatomy. It requires a habit of thought which aims at being all-embracing, and, along with an acquaintance with particular objects, a comprehension of all.

There is no legitimate occasion for giving up the old point of view, or, in order to find information on Physico-theology, to have recourse to the book-shelf. On the contrary, now for the first time, and that simply because of the most recent advances in science, has it become possible to account for the evil in nature, without hurting the spirit of adoration; while as to the good, it meets the eye as fast as ever, and proclaims as loudly as ever the goodness of the great Creator.

As to biology, the science of living beings and things, which is, of all

the branches of science, at once the most interesting and the most important (for it points continually to the knowledge of self), valuable progress has of late years been made in it. The rationale can now be given of not a few important biological facts, which have indeed been long known as facts, but which have never till of late been rightly understood. But, meantime, many more have been presenting themselves, the reason of which still remains unknown. And the confession must be made at the same time, that the more extended observation which has been taking place, has been increasing our consciousness of ignorance at a much faster rate than our knowledge.

Among those which are now well understood, however, some are very important, and their theory very interesting. Thus, since the earliest times, it has been known that, in order to be kept in life, an animal must continue to breathe and to receive nourishment; and it was easy to understand, and it was understood long ago, how certain creatures (a herbivorous animal, for instance) whose food was such that it could not all be converted into the substance of its body, must needs get rid of the unsuitable particles of its food by breathing or otherwise. But it was not understood till lately why an animal that fed on other animals, the composition of whose bodies was the same as its own, should be also dependent every moment upon respiration, which was nevertheless seen to be the fact (for the carnivorous lion or tiger cannot live one minute without using its lungs, any more than the herbivorous ox or horse). To explain how it should be so, all that was possible, until lately, was to suppose that the muscular machinery of animals broke down in the using, simply through wear and tear, just like that machinery which is the work of men's hands, and, therefore, that the debris of their tissues had to be got rid of and carried out of the organism in some way or other; and thus the existence of lungs and kidneys was explained and justified. This theory also explained the necessity of alimentation at the same time, and altogether it seemed to be adequate. It postulated, however, that the great Creator both contrived and executed His designs in the same way as man does, and under similar limits as to defective workmanship. There was reason to suspect, therefore, that it was intrinsically defective. And now that view has spontaneously passed away. Since the revival in our day of the Leibnizian doctrine of the conservation of energy in the material universe, it has been seen among other things, that inasmuch as every animal in all its motions is always putting forth energy, which is always passing from it into the ground, or into the air, or into whatever else gives the animal a purchase and a place in nature, so must that animal be always losing energy. And if it is to retain its strength, it must be provided with the means of continually drawing fresh energy

from its environments. Now, of energy it is known that there is a store in the action of the oxygen of the atmosphere ; and it is also known that this oxygen pours itself into the animal, as also, that when within the animal, it assails the carbon which was supplied in the food, and which, having been now exhausted by the work it has done, has become open to a successful attack by the oxygen ; whence there is produced within the animal a regulated supply of heat. This heat could not have been obtained consistently with organisation, otherwise than by some process which previously exhausted and exposed the carbon within the organism ; but this the exercise of the animal's activity does successfully. Thus while the life-engine is doing work, it is generating within itself heat proportional in amount to the work it does. Now, heat is the most elemental form of energy, and that which is available for the greatest number of purposes. It can no longer be said, therefore, that the break down of the muscular fibre under the work it does is a fault of the machinery, or in any sense an evil. On the contrary, it is a provision for the continued working of the engine. And thus respiration, instead of doing merely the work of a scavenger, as was long thought, does the work of a prime minister, the stomach being the commissariate, but nothing more, at least in the full-grown animal. The old theory, then, which implied a mechanical defect in the structure of the machinery of the active tissues, has vanished ; our conception of the work of the Creator is exalted ; and the whole conception is beautiful and satisfying to reason. And to this theory of respiration and alimentation, that of the circulation may be added, not only as being implied in the former, but as being well understood in its own details also.

It may, indeed, be said that by this change of view, the charge of defect in the muscular system of animals is not avoided, but only shifted from that of defective mechanism to that of vital exhaustion. Why, it may be argued, did not an Almighty Creator, if such there be, impart an adequate supply of energy to the tissue, to keep it fit for work as long as it could last as machinery, in spite of all that it might give off to surrounding objects ? Now, this is just one of those questionings which, though at first sight they may seem reasonable enough, yet, when looked into, are seen to be without justification. To ask for the supply of energy to mechanism at this rate is, in fact, to ask that there shall be no such thing as mechanism at all, or rather, indeed, no such thing as a creation at all ; for a machine which possessed within itself an inexhaustive store of energy would be a machine which could create energy,—would be, not a machine, nay, not a creature, but a creator.

Here, then, is an instance, and there are many others in which good progress in biology of late may be reported. But it is no less true, at the same time, that the number of problems which have emerged, and

which still remain unsolved, has been increasing in a much higher ratio.

It is seen, for instance, that an amoeba (seemingly nothing better than a little bit of animated glue) can extemporise a stomach for itself, and accomplish a complete assimilation of its food ; a protist creature, a mere structureless speck of protoplasm, can do that which we ourselves cannot do without a special stomach, a large liver, a pancreas, an elaborately convoluted intestine, &c., &c., and too often do it badly after all. Hence the problem, what the necessity, what the reason for these various certainly indispensable, and yet seemingly needless, appendages of the central canal of certain animals ?

Again, there are many minute creatures—insects, for instance—which, to judge from their actions, are as instinct with mind, and in some respects more so than man himself,—mind in man, by all that appears, being altogether dependent upon brain,—while in these minute creatures scarcely anything to call a brain can be detected at all ! The questions that may be or that are actually put are, in fact, endless, and are increasing every day. Moreover, sometimes they are such that they lie at the very basis of biology, at the root of all subsequent thought, craving an answer in the mind of every enquirer.

Such, for instance, is the question whether life and living things may not make their apparition where they were never before, and never have been introduced, in certain solutions, for instance, sealed when very hot, and supposed to have merely chemical contents ; or whether a spore, or ovum, or germ of some kind, itself the product of some living thing, must not have been first placed wherever life actually makes its appearance ? This question is plainly capital in biology. But the most eminent students answer it in quite opposite ways. Nor does science obtain any consolation, save in the invention of learned terms, formulating the speculation, as that, for instance, of “biogenesis” or “abiogenesis.” The ancients never doubted that putrefaction gave birth to living creatures, and was all the parentage they needed. The moderns, having analysed the careless observations of the ancients, and found that, not only in the cases they counted upon as proving this equivocal generation, ova had been laid by living creatures, similar to those which presented themselves in the putrefying substances, but that all, or almost all living creatures produce ova, capable of developing into creatures like themselves, voted almost if not altogether unanimously against the ancient view. But now the wave of belief is tending again to the old shore. All the experiments of a Pasteur and others, seemingly so exclusive of the ancient belief, and in favour of the modern “*ex ovo omnia*,” have not been able to prevent a Pouchet and others from bringing forward other experiments of a contrary bearing, while

a Haeckel admits that experiments have not proved it, but that, doubtless, originally living arose from dead matter.

Similarly also, Huxley, sanctioning the method of experiment, and, like Haeckel, halving the difference, gives it as his opinion that, so far as experiments have been rigidly made and rightly interpreted, there is nothing to contradict the adage of "*omne vivum ex ovo*," but that, for his own part, had he been present at the beginning of life, he would have expected to see protoplasm making its appearance among dead matter. He, therefore, contents himself with a conclusion which his accepted method of investigation does not sanction, and leaves us only his candour to admire.

Now what, may we not ask in passing, can be the cause of all this conflict among men of science as to the origin of life? Is it not explained by the narrowness of the current conception of life, and the lowliness of the point of view? The biologists of the present day never think of anything else but of seeking the living among the dead. Contrary to all reason, to all observation where the contact between the two is certain, they take for granted that death is antecedent to life. But is not the fact the very reverse of this? Of that fact is not "*omne vivum ex ovo*" a far too limited expression? Does not that fact, in its full extent, require rather the words "*ex vivo omnia*?" Yes; at the fountain head is not all life? Is not He who is there emphatically He who liveth for ever? And, having due regard to the kindred relationship that there always is between a cause and its immediate effect, is not that which we are reasonably to look for this,—that all nature, in proportion as it is protistic or lies near to the ever-living One, shall be found to be teeming with life? Let us not wonder, then, at the great embarrassment of men of science, so long as their thoughts never rise higher than to seek the living among the dead. But neither let us, on the other hand, manifest any sympathy with those quasi-theologically disposed persons, who seem to think that plants, and especially animals, alone require a Creator, while as to the crystalline world, and, indeed, all nature besides, it may go about its business, and be left in a merely aboriginal or atheistical or even antitheistical state.

And here let me make a correction, or rather an addition, to the remarks that have been made already on the subject of respiration. In these remarks it was presumed, as is usually done, that the only new source of energy obtained by breathing comes from the incidence of oxygen on the organism, and that the whole cycle of the energising consists in phenomena which are purely chemical or mechanical, which in the last analysis are the same. I desire here to add (though under the disadvantage as yet, no doubt, of its seeming a mere hypothesis), that on tracing the relative phenomena to their very source, it comes

out that respiration is precluded and exemplified, nay, we may say begun, by an agency on the sunbeam or the ætherial elements, which can impart power to these elements to supply what they impart to living nature, and consequently lose from themselves. Not that this Power, which is the first of things, and which presents itself to philosophy as lying beyond and above the sunbeam, is a property either of æther or of matter. It is Power in its very essence and fountain, possessed of all the highest attributes which are implied in the most complete idea of Power, and which Power is seen to possess anywhere. It is Power in perfection. It is, therefore, Power in unity, perfectly free or uncontrolled, perfectly perceptive or intelligent—in fine, possessing Personality. In a word, it is the omnipotent Author of all.

This is the first word of our philosophy. And hence there attaches to that philosophy the doctrine that, while the Author of all imparts power to those beings and things to which He has awarded existence steadily and harmoniously with their natures, so as to produce the vital, the dynamical, and mechanical phenomena of nature uniformly, He also stands in such relationship to all of them, as an Omnipotent Will holding them all in His hand, that by a procedure which may be justly called normal, that is, without any interference or miracle as commonly understood, He can empower or withhold power, in particular ways, forms, and cases, and so can order both individual life and cosmical phenomena as it may please Him.

To apprehend, therefore, as is often now done, and still more, to affirm, that human entreaty to the Deity for any physical change is necessarily impotent to obtain that change, and that even for a moral change such entreaty is nothing more than a mental discipline, is to entertain an apprehension, and to make an affirmation which is itself as unsound in science and philosophy as all mankind in all ages have shewn, by their prayers, that they feel it to be.

As to the denial, also, of the possibility, and consequently of the fact of miracle, that denial is valid only when nature has been so conceived and its course so defined as to exclude miracle according to a definition. Within the compass of such a definition, miracle is of course impossible, and there need be no inquiry about any historical miracle as to the evidence on which it rests. But such a conception of nature is not that of reality. It is not from the real world, but from an imaginary one, that miracle has been excluded in this way. As to reality, instead of its being near the truth to say that there never has been and never can be a miracle, it would be far nearer the truth to say that the whole course and economy of nature is one sustained miracle. That course, that economy does not excite popular wonder, indeed, because people are quite familiar with it and expect it, knowing that the same phenomena will recur

when all the conditions of existence are the same. This phenomena surely must do, since their Author is at once perfect in intelligence, and perfect master of His material, and therefore is not liable to make any mistakes, or to introduce any corrections, or to determine otherwise from moment to moment or from age to age, than as he determined at first when the material economy was instituted and set agoing by Him.

And here I may make a remark upon the term "law," as now usually applied to nature. This uniformity of procedure which is implied in that of a perfect intelligence, is commonly taken, or rather mistaken, for the fulfilment of a law. One hears of little or nothing else in science now but of the laws of nature and of phenomena. And such language is not only convenient, but, perhaps, in consequence of the poverty of language, it is inevitable. Still it is only rhetorical. It is not strictly scientific. There is a great difference, in point of fact, between the fulfilment of a law, properly so called, and the recurrence of a phenomenon in the course of nature. A law, properly so called, is a formula or rule of action framed at some past time for the regulation of the time to come. It is a fixture which, having originated in the past, is handed down to be worked in the present by some executive power who shall know, accept, and obey it. Law, in fact, stands in contrast with autocracy, or a self-determining power acting, as such, from day to day. Now, of the two it is the latter which is most applicable to the course of nature and the production of phenomena. Not that there is necessarily any difference in the issue or products of either mode. Thus, let us suppose a living executive power or prince constituted with such hereditary perfection, that his instinctive judgments and proceedings upon them should be always the same as those of the laws of the land where he was brought up, then in that case everything in the state would proceed according to law, just as it had done before his day, though now without any reference to statute or any recognition of it. The entire regulation and life of society in such a case would be due to the activity of a living presiding will. And yet, those of the population who were acquainted with the statute-book could predict in every case what the forthcoming proceeding would be. But surely this uniformity and certainty, this power of prediction, would not detract from the recognition of the will and the power of the prince. On the contrary, in virtue of his transcendent ancestral and patriotic instincts, he would surely command the loyalty and homage of all. Now, for a perfect intellectual heredity, substitute a perfect intelligence, with perfect knowledge of the capacity of his subject atoms, and we have something like a conception of the mode of procedure in the production of the phenomena of nature. Nature cannot be said, except in a metaphorical way, to have been ordered long ago, and once for all to be as it is now and

will be for ever. Nature is from age to age and from day to day the immediate expression of the ever-acting mind of the ever-living One, who, though not immanent in nature or one with it, is yet everywhere present to every atom in supreme power—able to modify or give birth to new phenomena to any extent, if He should elect to do so; in venturing to suppose which, however, plainly such ignorant and limited beings as we are should both think and speak with great reserve.

On this subject (in a small work published in 1855, and now no longer to be had) I have made the following remarks, with a view to show the harmony that there is between the expectation of the human mind and history on the one hand, and the course of nature on the other:—“*An opening must be kept for possible miracles.*—There exists in the universe free power. Consciousness bears witness to it in self. And its existence either in self or anywhere it is impossible to explain, or to satisfy the demands of reason anyhow, without admitting that free power exists in perfection in Him who is the Author of all,—in whom it has just been seen that philosophy must find its last word, in so far as the study of phenomena is regarded as the study of laws. Now, of a free power the characteristic is to originate acts which may be both new and singular, and under no law but that of liberty. *Such acts, therefore, and phenomena expressive of them, we are to expect in the world, if the world be fully a manifestation of its Author.* Yet, this under two conditions:—*First*, we are to expect them sparingly: for if in His ordinary providence the Creator put forth His free power from day to day in accomplishing new and singular acts, there would be no place for wisdom in man; experience would only deceive; forethought would be folly; and all science would be impossible. Whilst, therefore, philosophy leads us to regard the occurrence of such new and singular acts of the free power of God, as necessary in order to render creation fully expressive of the Creator, it leads us also to expect them but rarely; and, therefore, to find them bearing some name expressive at once of their rarity and singularity, such as the term ‘miracle,’ which has now supplanted every other.” It leads us also to expect them only in those points in which human nature comes into contact with physical nature, and in what we might call the singular points of the causes of social development and rectification.

* Elements of the Economy of Nature. A Fragment. Second Edition. Chapman and Hall, London, 1855, p. 2,

CHAPTER II.

THE PREVALENCE OF LIFE IN NATURE, PAST AND PRESENT.

ORDINARY observation leads us but little to suspect the extent to which LIFE exists now, and has existed in former ages, in our world. Compared with the amount of dead matter in the world, the number of living beings seems to be very small. And even to indulge, as an imagination, the thought that the crust of the earth can be to any considerable extent the product of the animated beings which have lived and died in our planet, seems very extravagant.

But when the naked eye is aided by the microscope, and due pains are taken to discover life wherever it may be now, or may have been in some former epoch, considerate and extensive observation leads to quite another view ; and, indeed, makes it difficult to say where life may not have reigned in some former age, or may not even still exist.

Into whatever realm of nature we pry with the microscope, if only there be moisture in it and oxygen have access to it, then what is found is this, that the higher the power of the instrument, just so much the greater its revelations of life, animal or vegetable, just so much the more numerous the living beings or things that are seen in the field of the instrument.

As to water in general, though it may be such as to have been hitherto held to be pure, chemists and biologists give it as their opinion, that in order to be free from life, it must have been recently distilled ; if not, it never fails, when analysed, to give indications of ammonia, which, as a product of the analysis of a natural medium or substance, is generally accepted as an evidence of the present or previous existence of living nature in the medium or mass subjected to analysis. And, indeed, without invoking the aid of chemical analysis or other means of discovery than the eye aided by the microscope, it is not easy to find any drop of water, which has stood exposed to the air for any length of time, which does not show itself to be teeming with living organisms.

It has also been demonstrated that the air is full of living things, as ova and spores, at least, if not as fully developed forms. There is, moreover, good reason for believing in the existence of the latter also in the air. It were strange and contrary to the analogy of nature—for nature is teeming with life wherever life is possible—that a medium should be capable of entertaining in it spores and ova in life for an indefinite time, and not be peopled with developing and fully developed organisms also. That they might be light enough to float in the air, and as fit every way for leading their lives in this medium as fishes are in the sea, there can be no doubt. And that they should be so small as to be invisible to the naked eye of man, is only what is to be expected; while with regard to the use of the microscope in this instance, it does not appear how it could be applied with a chance of success in catching them. Moreover, if caught, such is probably the delicacy of their organisation, that before they could be subjected to examination, they would most likely have been shrunk up so as to be mistaken for spores. In a word, nothing is so difficult as to find any region where man himself can live which is not occupied by other forms of life also. Nay, where man could not live a moment—where, till lately, it was believed that nothing could live, and that nought but eternal darkness and desolation reigned; in fine, the lowest depths of the ocean, like the sunny meadows and hill sides, are now found to be not merely teeming, but carpeted with living beings!

Nor is it only in quantity and diffusion that simple organisms everywhere abound, but also in exquisite symmetry and beauty. In comparison with many of them, everything among large animals seems slow and stolid, and often ugly. They are to large animals what lace-work is to matting. To be convinced of this, happily, it is not necessary to inspect them in the living state, which would be impossible for all but a few observers. Happily, an indefinite time after they may have died, one can study them at his leisure in the cabinet; for many of these beings, though so minute, have been endowed with the power of secreting, for their own protection while in life, a marbly or quartzzy framework, which is very durable, and which, under the microscope, proves to be of exquisite beauty. And in consequence of this, geology has already made the discovery, that not only are many strata of the earth's crust full of organic remains, but that strata to an almost incredible extent are wholly composed of them—composed of them to such an extent, indeed, as to suggest the inquiry whether those rocks which exhibit no traces of pre-existing animals, and are therefore named azoic, are devoid of such traces, not because there were no living beings at the time of the original deposition of these strata, but because the central heat, the abyssal pressure, and the chemical action to which these rocks

have subsequently been subjected, which have obviously changed them much (so much, indeed, as to have gained for them the name of metamorphic rocks), have obliterated all the traces of antecedent organisation.

No doubt the existing state of chemical hypothesis, as popularly held at present, implies that all the silicium, all the calcium, &c., which constitute the skeletons of these protista and protozoa, existed before the organisms in which these elements are found, nay, existed for ever, or, at least, from the commencement of creation, so that, instead of having been really secreted in any measure by these organisms they were merely taken up by them into their bodies from without. But if we do not embarrass ourselves with the chemical hypothesis alluded to (which rests on very insufficient evidence, and begins to be very seriously called in question, even by chemists),* if we fall back upon simpler views of the inner structure of material nature, and look to the obvious tendency of geological observation, we shall be led rather to infer that it is not with respect to ourselves merely, not among such animals and plants merely as happen to be visible to our eyes, that life precedes death, but that, far more extensively, possibly even universally, what is now dead is only what has been left behind of what formerly was alive. At anyrate, what we actually observe as to the relation of the organic and the inorganic, the living and the dead in nature, is this, that every living thing, either during its life excretes, or after its dissolution leaves behind it, a certain quantity of ashes or mineral matter. That all this, in every case, has been introduced into the living organism in the very forms in which it is given out by it, is generally maintained. But it is merely assumed, it never has been proved. Nor have many experiments, especially of late, been made to test it, because experiment in

* The popular chemical hypothesis alluded to is to the effect that there are in our planet some 64 elements, or different kinds of matter, the least particles of none of which are transformable into each other in any circumstances, or in any period of time, however long, and all of which are simple, primordial, ultimate, or even eternal, and eternally dissimilar to each other. The chemists may decline to express it in such strong terms, but it cannot be denied that on such a hypothesis all geological, all chemical investigations are conducted. It is incredible, however, that such a hypothesis can stand much longer, because it makes all nature in its ground a chaos, and the interpretations of the phenomena a continual struggle against everything that is feasible; its only evidence, meanwhile, being the fact that chemists have not yet succeeded in decomposing these 64, as they have gradually succeeded in doing with regard to other substances. But though these 64 were (like all other material particles) of a molecular nature, why should the chemist expect to be able to decompose them, since, before they have come into his hands at all, or been subjected by him to his mimicry of natural processes, they have been subjected for untold ages to the infinitely greater ordeal of the white heat of the sunbeam, the central heat and the volcano, and have survived it?

general is the slave of hypothesis, and experiments which in their issue might possibly damage a favourite belief, are generally avoided.

It may be stated, however, and it ought not to be forgotten, that, looking simply to nature for information, ashy or mineral matter may have what may be called a meteoric or fiery origin, as well as an origin from vital action. But here we have to consider the latter only.

Let it not be hastily inferred that, in that grand conception as to the origin of our solar system, which goes by the name of the nebular hypothesis, anything is implied which is inconsistent with a primeval vitality. Not but the attainment, on the part of our planet, of a certain central mass and density, implies the evolution in its interior of an intense heat altogether incompatible with the existence of such organisms as are known to us. Not but, in the present epoch of nature, it is only at a considerable distance from the centre that the temperature is mild enough for life, in such forms as we know it. But during the long ages of change from the nebulous state (whatever that may mean) to one which, in the central parts of the future planet, should be more dense, there is no evidence that heat was developed so rapidly as to be destructive of life, either about the centre or at any distances from it. On the contrary, the whole progress of scientific discovery rather points to an epoch of condensation, so long continued, so orderly and so gradual, that the degrees of heat generated may possibly have been the very temperatures which are most congenial to the construction of living beings, and to their enjoyment of life.

Viewing the world, on the other hand, as condensed to the degree that it now is, a sufficient cause appears both for those metamorphic and igneous rocks which geologists recognise, and for the obliteration of all traces of antecedent life during the genesis of these rocks. Notwithstanding this, however, every year is discovering organic remains further abroad, and deeper down among the strata, previously noted as azoic.

But since the reader may suspect that my argument might tempt me to exaggerate on this subject, let him peruse the following extracts from a small work* which very happily combines the character of scientific and popular, which, moreover, records only the work in building up the concrete part of our planet, of the simplest animals, and among these, the work of those only which give calcareous, not siliceous skeletons.

The author first adduces the work of the Foraminifera :—

“Our path now lies for a season in the crust of the earth. We must look into that mighty record of the past for proofs that the sarcode amoeba (see figs. 1, 2, 3, 4, 5) was a creature ultimately designed by

* Popular Illustrations of the Lower Forms of Life, &c. By C. R. Bree, M.D., F.L.S., F.Z.S. London, 1868.

omnipotent power to build up the solid portion of the world which man was destined to people. It has been the province of very recent investigators to prove that the amoeba is the oldest of known fossils, that it was the architect, unconsciously working away at a period so remote, that we can only realise it in any intelligible form by comparing it with the space we are told to think of, supposing the nebulous matter, which is resolved into stars by the high power of Rosse's telescope, reveals to us suns which are the centres of systems like our own."

"Now, beginning with the first fossiliferous period we find the Laurentian rocks composed of quartz, slate, and limestone, forming in many parts a beautiful veined green marble, occupying in Canada and New York an area of 200 square miles, and having a known thickness of 30,000 feet, and an assumed one of 90,000 feet, or, as Sir William Logan has suggested, a thickness which 'may possibly far surpass that of all the succeeding rocks, from the base of the Paleozoic series to the present time, carrying us back to a period so remote, that the appearance of the so called primordial fauna may be considered a comparatively modern event.'

"This extraordinary formation has been recently proved to have been formed almost entirely by Foraminifera. The amoeba, which formed the shell of the *Eozoon canadense* in those ancient waters, was at least twelve times the size of any known living species of the present day.

"It is not known as yet if any other animal lived in those ancient seas. On this subject the stone book is silent. There is, however, no decided proof that other animals may not have existed coeval with the Eozoon, although their remains are not found in the Laurentian rocks. They may have been destroyed by the heat which metamorphosed the sediment of those seas into Labrador felspar, hypersthene, crystalline limestone, and beautiful green veined marble, but which left intact the cast of the Foraminifera, and so perfectly, that the fossilised pseudopodia may be seen, like tufts of silver wire, radiating through its canals and chambers.

"For the time being then, at least, the *Eozoon canadense* must be considered as the oldest example of organic structure which the records of geology have revealed to us; and we must receive as a fact of science, that the lowest known sedimentary strata, for the depth of from four to sixteen miles round the earth, have been formed by the lump of jelly called the amoeba. The student will note that, although these Laurentian rocks have only been observed, say, in North America, Ireland, Sweden, &c., yet the geological inference is that they would be found to occupy the same position in all other parts of the world if the more recent formations were removed. Thus, were I to bore into the

crust of the earth, at Colchester,* I should expect, at a distance of $13\frac{1}{2}$ miles, to come down upon the Laurentian rocks.

"There is something truly practical and satisfactory in the revelations of a science which shows to us how gradually the crust of the earth was built up, and how far down that vista of time, in which the imagination may revel in awe and wonder, those mighty preparations were begun which culminated in the creation of man himself.

"It is, however, in the Cretaceous group of strata that the Foraminifera begin to appear most abundantly. It may surprise many of my readers when I tell them that the chalk cliffs throughout the world consist mainly of the remains of the Foraminifera. We cannot go where we will and examine the stupendous Laurentian rocks, but we can visit our chalk cliffs at Dover, or wander over our Sussex downs; and we can also realise the great use to man of chalk, when we see our farmers spreading it upon their stiff clays; and we can, without much trouble, follow the "white hills" into Ireland and Spain, France and Greece, for an extent of 1140 miles. We can follow them from the south of Sweden to Bordeaux, for 840 miles; and we can measure these cliffs, and find them to have a thickness of from 600 to 1000 feet; and then we can sit down in some snug corner and smoke our pipes, and ponder upon the wonderful fact that all the most important parts of our earth's crust have been built up by an animal, sometimes so small as only to be seen through the microscope—a creature without muscle, bone, nerve, or blood-vessel, a mere lump of jelly!

"At the beginning of the Eocene period, and contemporaneously with the London clay and Paris basin formation, we first observe the appearance of the Nummulite. It reached its highest point of development about the middle of the Eocene period, when at least fifty species are known to have existed. It then began suddenly to decline, appeared in less and less numbers in the later Tertiaries, and in our seas only a single species is known to exist.

"But in the period above indicated, this little Foraminifer had formed beds of enormous thickness and great extent in the crust of the earth. Some idea of these extraordinary strata—known as the Nummulitic limestone—may be gathered from the following extract taken from Professor Haughton's 'Manual of Geology,' pp. 176 and 177:—'The geological distribution of Nummulites is most remarkable, as they are found along the entire line of mountain chains from the Pyrenees to Thibet, and occur at all altitudes from 8000 feet and 10,000 feet in the Pyrenees and Alps, to 15,000 feet in the Himalaya mountains; they

* The author resides there, and his statements were originally addressed to people there.

form a geological zone stretching W.N.W. to E.S.E. from 10° W. long. to 55° E. long., having a width of 1800 miles. Farther to the east it narrows considerably, but the entire length from west to east embraces 98° long., and its breadth from north to south ranges from the 16th to the 55th degree of north latitude.

"The Nummulitic limestone surrounds the entire border of the Mediterranean Sea and the Black Sea. It constitutes a large portion of Egypt and of Asia Minor. . . . It is found in the elevated regions of the sources of the Tigris and Euphrates, and extends from Upper Armenia to the Persian Gulf. It also stretches eastward from Armenia along the valley of the Araxes by the chain of Elburz and the plateau of Irau, as far as the mountains of Cabul and the Punjaub. It completely surrounds the valley of Cashmere, and rises in the chain of the Himalayas to a height of 15,996 feet, from which altitude it descends on the south-east of the chain along the right bank of the Indus, forming the lower hills of Beloochistan. Still farther to the east it is found in the mountains of Kossya, between the Brahmapootra and the plains of Bengal.'

"I need say but little more to prove the important agency assigned to the amoeba in building up the crust of the earth. In all this there is a vast proof of the design with which this lowly organism was created. Take away the Laurentian rocks, and the chalk, and the Nummulitic limestone, and *the crust of the earth would tumble to pieces*. And yet they were formed by a lump of jelly that could only have the blind instinct of self-support and self-preservation.

"And the same design is being carried out in our time for the probable creation of a future world, in which man himself may be the most important fossil.

"The bed of the Atlantic Ocean, even at a depth of two miles, is covered by ooze teeming with Foraminifera, ninety-seven per cent. of the soundings at the above depth being found by Captain Dayman to consist of Globigerina. They are principally found in the Gulf Stream and follow its course. Does this indicate a future group of hills or mountains having such a range? The coasts of Australia are crowded with living Foraminifera; in fact, they are found in the soundings of most tropical seas, and the greater the depth, as a rule, the larger the specimens. They occupy fifty per cent. of the ooze in the deeper waters of the Mediterranean, Adriatic, Red Sea, Canaries, West India Islands, east and west coasts of South America, St Helena, and Isle of France.

"The history of the Foraminifera is part of that of the earth. I have in this paper endeavoured to show how intimately the study of animal life is connected with those higher generalisations upon which the science of geology is founded. How much is our interest heightened

in that drop of water under the microscope, and that protean lump of unsymmetrical sarcode called amœba, when we associate them with the physical architecture of the world, and the forethought and design of that world's Creator!"

The author afterwards proceeds to notice the work of the coral polype (fig. 6).

"But there is no part of the interest attached to the coral of greater significance than that which we shall find connected with its history in the formation of the crust of the earth. The thousands of islands, which, for the space of 16,000,000 of square miles, are found in the Great Pacific Ocean, are almost entirely formed of coral. All the north-east coast of New South Wales, for upwards of 1000 miles, has a barrier reef of coral. In the Indian Ocean the immense chain of islands known as Cosmoledo, Saya de Malha, Chagos, the Maldivas, and the Laccadives, are all formed of coral occupying a space of nearly 2000 miles. The eastern coast of Africa, from Mozambique nearly to Ajan, upwards of 1000 miles, is an immense fringing reef of coral. The coasts of the Red Sea are almost entirely coral. Turning again to the Indian Ocean, we find the south-west coast of Sumatra and the southern coast of Java fringed with coral. From the northern extremity of the Celebes to the Philippine Islands, thence to Bashee, Patchow, and Loo Chow, and back to the China Sea, we find the Paracells and other large islands all formed of coral; and, lastly, for I need not continue details, the islands of Bermuda and the West Indies are surrounded by fringing reefs of coral.

"This rapid glance at the works carried on *in the present day* by the polyp which forms the coral, will give some slight idea of the immense importance which this creature has possessed in fashioning the form of the earth's surface. If we go below this, and look at the records of its working in time, our astonishment will be vastly increased. Some of the most interesting problems connected with the age of the world are solved by these records."

The creatures by which such mundane quantities of concrete earthly matter are produced, are, as I have stated, of the simplest structure, and usually the individual is of a very minute size, or, more correctly, their organism is, so far as appears, but little differentiated, and they are so minute, that probably there are many of them which are too small for even the highest power of the microscope to render visible. At any rate, beneath the horizon, within which the highest power of the most powerful microscope can detect objects or particles different from the liquid medium in which search is made, there is every reason to believe that there is still a lower, or, shall I not rather say, a higher world teeming with life. I have said that these creatures of the dawn, or protozoa,

are to be described as not visibly differentiated, that is, they do not exhibit to the eye many different tissues or organs as larger animals do. For this reason they are commonly spoken of as very simple—mere specks of living jelly—and so forth. But all that is really seen is this, that they consist of a transparent substance, which, when burned, gives universally the same chemical elements as its constituents. But when it is considered how manifold and how marvellous the powers of that substance are, reason checks the eye in affirming this to be so very simple. As to their external forms, they are so multifarious as seemingly to defy any generic descriptions, even the most reserved. Sometimes even the same species, nay, the same individual, appears to have power of affecting all imaginable forms, and to be a very proteus, which name has indeed been appropriated for some of them. To acquaint himself with them, the reader must have recourse to works on zoology, and mark the forms and powers of the Rhizopoda and the Infusoria, the Hydrozoa, and the Actinozoa, as also the succeeding orders."

Referring to the sponges also, the author from whom I have quoted so largely makes the following remark:—"The sponges are found fossil in the oldest rocks. They attain their maximum in the chalk. Most of our flints have a sponge or its spiculæ as a nucleus, round which the siliceous matter has accumulated." The sponges are, indeed, very different from the other creatures which have been noticed. But they do not fail to contribute their share to the crust of the earth.

There are other organisms also which, without any adequate reason, naturalists are more disposed to refer to the vegetable than to the animal kingdom, or to an organic realm lying between the two which has been named that of the *Protista*, by which it appears that material for rocks has been supplied to a vast extent. Such are, for instance, the Diatomaceæ, of which thousands of species have been ascertained to be still living and dying, and leaving their beautiful siliceous shells behind them to increase the quantity of dead matter in the crust of the earth. Composed entirely of such shells, extensive strata and beds of stone are found here and there among the strata of our planet. They are individually so minute, that Ehrenberg estimates that, in Bohemian Tripoli, there are 187 millions in a single grain weight, and yet, at that place there is a stratum extending over a wide area which is no less than fourteen feet thick.

To the seremarks some others may be added from Lyell's Elements of Geology.

He states what is still more interesting in reference to the view in which we are now regarding such occurrences in the upper part of this stratum, that there is "another heavier and more compact stone, a kind of semi-opal, in which innumerable parts of Diatomaceæ and spi-

culæ of the spongilla are filled with, and cemented together by, siliceous matter. It is supposed that the siliceous remains of the most delicate Diatomaceæ have been dissolved by water, and have thus given rise to this opal, in which the more durable fossils are preserved like insects in amber. This opinion is confirmed by the fact, that the organic bodies decrease in number and sharpness of outline in proportion as the opaline cement increases in quantity." Treating of the origin of metamorphic rocks, the same author makes these remarks :—" Now, the alterations above described, as superinduced in rocks by volcanic dikes and granitic veins, prove incontestably, that powers exist in nature capable of transforming fossiliferous into crystalline strata—powers capable of generating in them a new mineral character, similar to, nay, often absolutely identical with that of gneiss, mica-schist, and other stratified members of the hypogene series. The precise nature of those altering causes, which may provisionally be termed plutonic, is, in a great degree, obscure and doubtful ; but their reality is no less clear, and we must suppose the influence of the heat to be in some way connected with the transmutation, if, for reasons before explained, we concede the igneous origin of granite." And again,—“The total absence of any trace of fossils has inclined many geologists to attribute the origin of the crystalline strata to a period antecedent to the existence of organic beings. Admitting, they say, the obliteration, in some cases, of fossils by plutonic action, we might still expect that traces of them would oftener occur in certain ancient systems of slate, in which, as in Cumberland, some conglomerates occur. But, in urging this argument, it seems to have been forgotten that there are stratified formations of enormous thickness, and of various ages, and some of them very modern, all formed after the earth had become the abode of living creatures, which are, nevertheless, in certain districts, entirely destitute of all vestiges of organic bodies. In some the traces of fossils may have been effaced by water and acids at many successive periods ; and it is clear that, the older the stratum, the greater is the chance of its being non-fossiliferous, even if it has escaped all metamorphic action."

In the review of what has been advanced in this chapter, it may, perhaps, strike the reader as strange, that the burden of the earth's crust should have been laid to such an extent upon animal beings, and not rather upon plants. The prevalent impression is that the vegetable preceded the animal kingdom. And it is certain that vegetable remains, in virtue of the carbon which they contain, can give solid strata which may possibly last as long in the crust of the earth as any other, attaining, in different epochs, the successive states of flaming coal, glance coal, and ultimately plumbago. But minute research into the intimate structure of the living cell in plants has shown that its lining and living part

is the same as that in animals, and that the vegetable matter or cellulose which characterises plants is of the nature of a very delicate shell encrusting and protecting, and supporting the living part. The simplest plants, therefore, must be viewed as farther away from the beginnings of life than the purely sarcode animal, and analogous to those which, for their protection and support, secrete calcium or silicium. But here the philosophically minded observer is reminded how inadequate merely popular distinctions are to form the ground of a truly scientific classification of the productions of nature. Multitudes of organisms present themselves in the field of the microscope with regard to which some of the most approved naturalists maintain that they cannot be called either animals or plants, and for which they have, therefore, instituted the kingdom *Protista*, as lying between decided *Protozoa* and *Protophyta*. Meantime, no generally accepted definition either of an animal or of a plant exists. A popular conception merely, which is extremely vague, is left to rule. This classification of organic nature, therefore, into three kingdoms instead of the two, the third embracing organisms in which it is thought that the characteristics neither of animal nor of vegetable organism and life distinctly appears, implies no more than this, that in descending the scale of organisation, now in the line of animals, now in that of plants, with a popular conception of what an animal and what a plant is, we come, at least, in both lines to organisms, with respect to which we do not know whether to refer them to the one kingdom or to the other, and so, as a haven for our ignorance, we institute for them a third kingdom. Nothing, however, either in organisation or function, has appeared in them to justify such an institution. Its true place, therefore, if such there be at all, is that of a parenthesis or appendix for receiving organisms which, at present, it is deemed improper to classify in either of the two established kingdoms of nature.

As to the eight classes of Hæckel's *Protista*, most of them have hitherto been regarded as animal organisms, and have been treated of by zoologists, and there is no good reason for making them change their zoic place. This also is eminently the place of his first order, his *Gymnomera*, of which *Bathybius Hæckelii* is adduced as an oceanic, and *Protamœba primitiva* as a fresh water, example.

Moreover, these *Monera*, it is to be remembered, are the organisms out of which Hæckel raises the whole of the living world, both of animals and plants. There is nothing, then, in his class *Protista* that is adverse to the views now advanced, which regard animal nature as the first manifestation of life in our planet.

CHAPTER III.

INDICATIONS OF A CERTAIN RECURRENT FORM (THE NAKED OR APPENDICULATED SPHERE) AND CERTAIN NUMBERS ($12 + 20 = 32$) IN LIVING BEINGS AND THEIR PARTS.

BIOLOGY, the science of life, when treated as a branch of philosophy, which is our present aim, has for its object to know and understand, as also to account for, the forms, the structures, and the functions of living beings and things.

Now, in order to make any progress in such an inquiry, our intellectual weakness obliges us to direct our attention first to those which appear to be most simple, and which, therefore, are probably most easily known and understood. Moreover, according to our conception of the origin of nature, this is also to begin at the beginning; so that her philosophical propriety sanctions what logical necessity imposes.

It will assist us if we consider these simple beings as they exist—

1. In confinement.
2. In freedom.

In the former situation are those living and ever transforming cells of which the entire animal organism, so far as it is alive, consists, and of which, when these living embers are normally being transformed and cemented together, it is in the main constructed. But comparative anatomy is still in a state far too crude and rudimentary to undertake the discussion of these organic elements. Nor, indeed, does it seem desirable to consider them as individualised beings (*Endocystica*), distinct from those which they constitute.

The case is different when there are found in animals, organisms which are truly animated, and which yet form no organic part of the animals themselves in which they are met with, such as entozoa, gemmæ, ova, spores, &c., of which we may adduce, as an example, fig. 1, *a*. It represents (highly magnified) an encysted or reposing Gregarina, an inhabitant of the intestinal canal of insects, &c. It also represents *Amœba sphaerococcus* in repose, also highly magnified. This animal

consists of a spherical mass of plasma, which encloses a nucléus together with a nucleolus, and is surrounded by a cell membrane."—(*Hæckel Schöpfungsgeschichte* p. 380.) But it may equally well represent the drawings of ova in the same work, both those of invertebrata and vertebrata (see Plates VI. and X.), and in physiological works generally. Respecting amoeba in this reposing form, Huxley says, "No doubt many persons will be struck with the close resemblance of the structure of this body to that which is possessed by an ovum. . . . You might take the more solid particle to be the representative of the germinal spot, and the vesicle to be that of the germinal vesicle, while the semifluid sarcodal contents might be regarded as the yolk, and the outer membrane as the vitelline membrane. I do not wish to strain the analogy too far, but it is at any rate interesting to observe this close morphological resemblance between one of the lowest of animals and that form in which all the higher animals commence their existence."*

That the lowest and the highest products of organisation, and those whose development is the most diverse in the world, should thus appear to the eye to be so similar, shows the utter hopelessness of morphology if the natural eyesight alone is to be consulted, without due regard also to mechanical or rational principles. Naturalists too often think of the last molecular or moving things rendered visible by the microscope (which, compared with ourselves and the common furniture of the world around us, are of course very small), as if they were among the very least things of a molecular or moving kind that nature produces, when, in point of fact, they more probably are to the latter as African elephants to infusory animalcules. Physiologists, also, too often allow themselves to infer homogeneity in a soft mass or morsel of any kind, however marvellous its powers may be, merely on the strength of having observed an equal amount of transparency, or a similar coloration all through! But surely such an inference is most unwarrantable, even on the principles of the most obvious logic. And moreover, the spectroscope has shown of late, and that to the eye itself, how incompetent this organ is, when informed by natural light merely, to observe differences, even when they are of quite an elemental character.

Can anything be more certain than that the intimate structure of a human ovum, which has latent in it the power of developing into the form and structure of a human being, and that only by an action sustained during many years, must be entirely diverse from that of an amoeba, which within a few minutes can extemporise legs and arms for itself, nay, a stomach also, and digest its food without a visible trace of any of those viscera which man must possess, and that in a state of

* An Introduction to the Classification of Animals, p. 8.

health and activity, before he can do the same? And how diverse, also, must the intimate structure of that *amœba* be from a morsel of glue, with which, nevertheless, biologists compare it, and which, no doubt, gives a somewhat similar image on the retina? Let us indulge in no such inferences, in no such comparisons. They are most unscientific. Our eyesight was given us for showing us neither the limits of the universe nor far into it, but, on the contrary, for enabling us to seize our food, and take notice of such objects as are dangerous to our bodies, while these objects are yet at some distance from us, and we may possibly master them or escape from them. For all that belongs to the sphere of science, properly so called, it is the mind's eye reviewing the observations of the material eye, it is the interpreting power, it is reason alone, that we can consult with advantage.

However, in the field of observation and thought to which these remarks apply, this much appears to the eyesight, that individualised objects, when their simplicity is a maximum, and when, though possessing life and capable of development, they are in a state of repose or hybernation, tend to possess a spherical or cellular form, containing within it a nucleus, as also often a nucleolus. This, the form and structure of every cell when it is as yet unchanged, and is just beginning its individualised or centralised life, and every encysted *Gregarina*, *Amœba*, &c., and spores and ova in general, demonstrate.

But let us not proceed farther without asking whether we are right in regarding *Endocystica*, *Gregarinida*, ova, and the like, as complete, unmutilated, or unshorn objects. They are all intestinal, internal, or imprisoned organisms, occupying walled interiors where delicate extensions of their substance, as well as free locomotion, must be forbidden them. Hence, is there not reason to suspect that they may be defective, or shorn of those delicate extensions of substance or organs of locomotion which are the characteristic endowments of animal nature? Suppose, then, that we have similar morsels of protoplasm, let us say, in a situation where free growth and movement are possible,—in open water, for instance,—what do we find respecting simple organisms when there? To this the general answer is, that while, previous to change, as in imprisoned organisms, the spherical or spheroidal form and an analogous structure still prevail, yet the free organism is now usually furnished all over, or in certain parts, with banks of oars named *cilia*, by the rapid movement of which it can change its place, and flit about freely in the liquid medium in which it exists. Such are the first forms of *algæ*, sponges, polypes, medusæ, &c. (figs. 8 and 9).

But here among such objects there is to be observed a very remarkable difference. Some of them (fig. 9) change their spherical form but slightly if at all. They do not develope into other forms, either plant-

like or peculiar. On the contrary, they produce, either in their own interior, or in juxtaposition to themselves, small bodies like themselves, which, by their own opening or dissolving away from around them, they liberate, and which, when liberated, have the power of continuing the race.

Moreover, many of these spherical or spheroidal bodies (see fig. 9) show themselves to be not homogeneous or simple spheres or spheroids, covered more or less with *cilia* all over, but composite forms, built up of a multitude of little spheres or spheroids, each spheroid having perhaps only four, more usually only two, and ultimately only one cilium (figs. 10 and 11). And here one is tempted to consider the exquisite structures and phenomena displayed by lasso-cells, spermatozoa, antherozoa, pollen, &c. But the connection of the flagellate form in the individual with the spherical group, out of which it has emerged, has not been studied, and a statement of the relations here would be almost purely theoretical, and incapable of verification. It may be remarked, however, that when the cilia or linear appendages are long, their normal nîsus at the spherical keeps twisting these appendages round the spheroid to which they are attached, and so imparts to them usually a spiral or undulating motion. Of this, endless illustrations are given in the reproductive elements (see the aquatic cryptogamia, such as the Characeæ, &c.).

Very manifold are the representatives of cilia (tentacula, pedicellariæ, ambulacral tubes, &c.) Cilia are, indeed, so slow to disappear entirely, that they are still found, and that retaining their vibratory action, on the surface of many membranes in the most highly-organised animals (in man himself, indeed), when one face of the cells constituting that membrane is free.

But let us now hasten to remark that many ciliated spherules, instead of opening up and liberating offspring like themselves (as *Volvox*, fig. 9), after they have indulged for some time in moving freely about, thus diffusing the species while the parents die, settle down on some suitable solid stage; and by-and-by there grows from them spiculated or tentaculated structures in endless varieties in nature. Of these nascent structures, the polype form, a hydra-tuba (fig. 12), may be taken as an illustration. This in its turn may ultimately give being to a free swimming medusa (fig. 13); and of these there is in nature a host so multitudinous, that in certain latitudes and states of the weather they render the very ocean luminous, and supply food even for the whale. Or emulating a plant, the polype may bud and branch again and again into all the exquisite forms of the zoophytic and coralline world. Still, it appears that all this branching and building again is but a nîsus by means of axis budding upon axis, and equator branching upon equator,

to retain the growing forms overhead or in its limits with the ambient medium, as spherical as the conditions of existence will allow. In consequence of the space below it being occupied by the rock or other object it rests upon indeed, the zoophyte scarcely even attains to more than the hemispherical in form. And further, in proportion as the animated mass becomes less completely individualised, it inevitably becomes at the same time less centralised and less emulous of the spherical. The more of dead matter also which the composite structure contains, whether siliceous spiculæ or calcareous granules, the less symmetrical its form may be expected to be, the greater the departure from a spherical contour.

We take then the appendiculated sphere as the type of form for a fully individualised organism when most simple, perfect, and free, as for instance the ciliated ovum, fig. 8, which may represent either the ovum of a *cristatella*, or one of those bodies found in flint, which have been called *Xanthidia* (fig. 15). As other examples, I may also allude to the *Radiolaria* generally. Say *Heliosphæra inermis* where the protoplasmic arms and body are supported by a siliceous skeleton of a spherical form, composed of hexagonal lace or lattice work, possessing the most geometrical and beautiful structure. It is, indeed, so elaborate and so geometrically accurate, that it is difficult to draw a diagram of it. Let us, therefore, be content as a type of this whole class of beings with fig. 14, the sun animalcule, a familiar microscopic object.

And here there meets us one of the most interesting and important facts in the economy of animal nature, namely, *the secretion* by the living organism of matter which is dead, and *its utilisation* to give support to the living organism. If animals are ever to attain to any considerable size or durability, something of this kind is manifestly needed; for the living parts of an animal, inasmuch as they must be always easily transformable, must always be mobile, and therefore always soft and yielding. But if they are so, then except when the animals are very small, and live in a medium which is of the same specific gravity as themselves, they must be liable, under the sustained action of gravitation and incident forces, to be all flattened and spoiled as to form. Hence a necessity that supporting material be provided. Now this, animals in general have been enabled to do for themselves. Certain of the particles of their bodies die, and become dead, most probably, after they have served the purposes of life and been exhausted. And these dead particles become good material for constructing supports; for a dead particle is merely a particle which is not readily liable to change, a particle, therefore, just such as is wanted as material for the skeleton of an animal. Now, of such a kind are pre-eminently particles of silica, and of carbonate and phosphate of lime, that is, the

very substances which the simplest animals secrete in great quantities. And hence, in early ages, abundant material for forming the shells and skeletons of animals. But is this all that we have to say upon the subject? Does this economy come to a close here? In the lapse of the time during which our planet gives evidence of its existence, a time which seems all but infinite, must not the accumulation of such dead stable matter in it be immense? And why, therefore, when we come to consider the case of the planet itself, should we part with the conception, that this dead matter is provided as material for a support? Why not a support a shell or crust, not merely for the individual organisms which secrete it, but for their general home, the planet itself, which would have been too soft and yielding without it?

Not that we are to infer that the entire mineral matter of the earth, or even the greater part of it, has, or must have been formed, in this way. Dead or mineral matter would also form rapidly, all independently of the secretions or excretions of organised beings, as soon as the nuclear condensation of our planet had become so great, that the central heat thus generated surpassed a certain temperature. After that, the heat would transform the aqueous matter of the primæval abyss into mineral matter. Much of the crust of the earth may, therefore, have had what may be called a meteoric as well as an organic origin. But in keeping with the view advocated in this work, it cannot be denied, that the whole tendency of geological research is to increase the quantity of organic matter. This is, according to our view, the normal mode of the genesis of the crust of the earth; and by this view the same theory of the origin and use of mineral matter applies equally to the microscopic amoeba, and to the world itself.

As to the origin of this dead matter as a secretion or excretion of that which has life, it is probably necessitated by the law of the conservation of force, and inevitable, the elements of the material system being what they are. But though inevitable, it need not therefore be useless. It is universally admitted, that it is needed, and even necessary to be a support to living creatures, almost from the least to the greatest; and now it is suggested that it is also necessary to the world itself, in order that the world may be a suitable theatre for their existence and entertainment. Here then we have an instance of that marvellous economy, which is constantly presenting itself to the reflective student of nature. Some object or incident appears which, other things being as they are, is unavoidable, which, therefore, may be expected to be merely an encumbrance, or if it serve one purpose, that is all that can be reasonably looked for; instead of which, however, it is found to be essential to the whole system. And we are taught that it is only in consequence of want of compass in our own thoughts

that we ever felt a difficulty about it, and were tempted to wonder rather than to adore.

Such a generalisation (which refers to the same category, and uses the same ideas to explain the existence of every shell of a microscopic *Orbulina*, and that of the crust of the earth itself), will not go without a criticism invoking the aid of ridicule perhaps. But that can be easily borne. That is not the worst of it. The reader will not fail to perceive, that such a view is entirely at variance with the chemical hypotheses which are at present in vogue. But it is no less true, that it is not at variance with the traditions of science and philosophy in general, from the earliest times. And if it explains phenomena, it is worthy of being listened to; for the actual state of science has no account at all to give of the origin of the materials of which the supports of animals are formed—unless, indeed, if it be that they were to be found as ingredients in the original cosmic vapour—where, however, it is certainly as uncomfortable for reason to find them as in the bodies of animals, or in the crust of the earth.

At present it is generally believed, as has been stated, that these minute animals take up the mineral matters found in them entirely from the waters of the ocean or of the ambient medium, be what it may, in which they live. And, doubtless, if these materials occur in the animal's food, the animal will utilise them for the construction of its skeleton. And probably the quantity which any individual animal, even the longest lived, can transform of one element into another—of nitrogen into silicon, for instance, is infinitesimally small. But to maintain that all the dead or mineral matter found in animals has been brought into them from without for ever, is to maintain a hypothesis which puts a stop to all biological research, and which, by the experimental results of some of the best analytical chemists, is believed to be contradicted even by the incubation of every hen's egg. And if it be so; if during no more than twenty-one days, phosphorus and calcium, even in appreciable quantities, make their appearance in so small a mass as the chick in ova, how great must not the whole quantity be which has been produced by life since the first creation, a period too remote to be distinctly conceivable? It is, indeed, affirmed by many chemists that, after making the most careful experiments on incubation, they do not find, either by the balance or otherwise, any evidence of the increase of quantity of lime or phosphoric acid, or of anything else which may not have come from without, during the change of the glairy contents of an egg into a feathered fowl. But how many millions upon millions of atoms must have been produced before any of our gross senses could in any way detect them! Compared with the fineness of molecular nature, the

most sensitive chemical balance with $\frac{1}{1000}$ of a grain in the pan, is a beam in a warehouse weighted with bale goods.

But to turn from the dead to the living, it may be said that the simplest forms of life have been best observed in amœba. In its reposing form, or what may be called its form of hybernation or when encysted, *A. protoccus* is represented in fig. 1, *a*. The tribe is one which contains immense multitudes. In a state of activity, *A. radiosa* is represented in fig. 1, *b*. Here the nucleated "morsel of glue" has extended in all directions legs and arms, which it can extemporise out of any part of its body when it is hungry. These it gathers up when it has caught a particle of food, so as to form, in like manner of itself and for itself, an extempore stomach which can digest whatever is taken into it. Again, therefore, after this phase of activity, the amœba resumes in a general way the spherical form.

And here, were we to take anything like a full review of the forms of the most simple and abundant creatures, we should require to give much time and many words to the medusidæ, those specks of jelly (see fig. 13) with which the ocean teems to such an extent that in certain states of the weather, as has been already stated, the sea is even rendered luminous by them. But we must content ourselves here with stating that, on a general view of their forms, it may be said that when they have other means of locomotion (such as cilia, &c.), they are more or less *spherical* (Beroe, &c.) When they have no other means of locomotion but their own forms they are more or less *hemispherical* (Medusidæ). Now, while the spherical is of all forms the worst shaped for effecting locomotion by itself, the hemispherical, which is but half spherical, is well calculated to do so, especially if the edge, or equatorial part of the form, be thin and mobile; for then it must be ever tending to make a nîsus at the spherical; and this tendency cannot but be sustained rythmically, like all other similar vital movements. In a word, the mobile-equatorial edge must be ever pressing downwards and inwards rythmically, bent on forming another pole opposite to that which exists already. And thus its hemispherical form must propel the animal in the direction of the already existing pole. For the same reason (the development of the spherical) we are also to expect, as appendages to the hemispherical fan or umbrella, marginal tentacles, &c.; and in the line of the axis an axial polypite, stomatodendra, &c. In short, our theory accounts to a great degree of minuteness for the unseemly and strange organisation of the medusidæ, which, considered as to form and structure merely, seem to have rare pre-eminence in nature, since they are not only so abundant but often attain to a size so large that nothing else in nature that is so simple and so aqueous can approach them.

The bioplasmic protozoon, while it forms a support for itself more or

less of a rigid or stable nature, and in so doing is obliged to die in part, is not always, or even often, able to maintain its unity, its individuality. Most usually it becomes in this case a composite animal, or a community of animals. This is beautifully illustrated in the amoeba tribe itself, or the Rhizopoda as they are called. The animal secretes or excretes abundantly calcareous matter for protection and support. But, except in a few instances, it cannot detach itself from its own house before the time when a child or germ is at the door bent on building another house like that of its parent and adhering to it. And hence multiple cabins and inhabitants in one vessel, with doors, or rather port-holes, all over and through it. Hence, in a word, the most extensive tribe of the foraminifera, which are still forming and in the former ages have formed, as has been shewn, to a very considerable extent, the crust of the earth. Still, in this tribe unity and individuality reign to such an extent that, in modern times at least, the community is never a large object, and its structure is always symmetrical. Nay, here also it looks as if the architecture of the whole community were so conducted that the finished work should be as spherical as the conditions of growth would allow. Thus some, as *Globigerina*, *Orbulina* (fig. 3), are spherical, and those which depart farthest from the sphere may be described as either axial, as *Nodosaria* (fig. 4), or as equatorial, as *Spirulina* (fig. 5), the others being intermediate, as if constructed upon the skeleton of the sphere as the type—that is, upon an axis either as such or as a system of meridians with an equator. In these cases, then, the animal is no longer single; it is a composite animal. Still, however, the principle of individuality reigns to this extent that the form of the composite animal attains a stage in which it is full grown, and its further growth comes to a close in a limited specific form.

But when the bioplasmic creature has been differentiated to such a degree as to be a polype, with tentacula definitely limited in number (coral polype, fig. 6), the secreted dead matter has gained upon the living to such an extent, that the creature can no longer, in the most notable cases, call a halt to the continuous deposition of that matter. The deposition, therefore, goes on continuously until the limiting or destructive action of external nature prevents further additions. Such are coral-forming creatures, *Sertularidæ*, &c.

In reference to these, it is only such as grow upon projecting points, or in other favourable situations, which remind the observer of the sphere, and that overhead only.

With regard to each individual polype, however, it displays the sphere in its gonospore, and its own form when retracted or reposing.

When expanded, also, it displays an equator formed by a system of expanded rays or tentacula when the creature places itself fully in

relation with its environments, the body and axis of the animal being the hemisphere on its own side, and a circling eddy of water, caused by the tentacula on the hemisphere, on the aqueous side.

But when the animal retreats, so as to be as complete in itself as it can, the equatorial radii, or tentacula, close up as meridians, thus developing the spherical. And ultimately all is huddled together in a little ball.

Ascending the animal scale, it is to be found that unity has regained its ascendancy again in the sea-urchins, star-fish, &c. And in these the spherical or its skeletal elements, the cylindrical or axial (sea cucumbers, &c.), and the equator or radiated disk (star-fish, &c.), appear more distinctly.

I shall not, however, at this stage of our work, proceed to trace the prevalence and recurrence of the spherical in form any further. Let us rather hasten here to remark, that while a type of types, or archetype of form, thus appears to be embodied in organic nature, something of the same kind may be observed as to the number of parts and organs displayed by organic beings. There are prevailing and recurring numbers, their sub-multiples and multiples.

Thus, in polypes when developing, how often do the tentacula commence in four and rise to eight, a number which continues permanent in all the many and infinitely numerous coral polypes. Among the finest algæ, also (*Ceramiceæ*), their most conspicuous feature is the tetraspore. And in the peristomes of the mosses the series of numbers is found complete. It is, indeed, true that this dichotomous series is precisely that which the law of the equilibration of equal and similar forces gives also. But that consideration explains only a few of the phenomena, and is no argument against the existence of typical numbers at the root of nature. It merely bespeaks the universal harmony of things; and it gives no reason why in the dichotomous series certain numbers rather than others should prevail. Thus, in the very extensive family of mosses very widely distributed in our planet, and containing many hundred species, the number of teeth in the peristome is, in a vast majority, thirty-two. And what if that which we may call the peristomes of the most perfect animals give the same number! No anatomist can give a reason why the teeth of a mammal should be so many as they are, and neither more nor fewer. And yet how strangely they manifest certain numbers. Thus, in the human species the first set of teeth are twenty in number. To these, in the permanent set, twelve are added, making thirty-two in all. The same is also the number in the apes of the old world, which most nearly resemble man. It is also the number in those flocks and herds which man makes his companions and grazes in his fields and parks, and which are so invaluable to him. Other animals, again, as the pig, have first thirty-two, and when all their teeth are mature and

accounted for, they have $32 + 12 = 44$. Others, again, such as the new world monkeys, when looked at with their jaws closed, may be regarded as having their teeth in three sets of twelve each, 36 in all, one set of twelve being the incisors, guarded on both sides by the canines; while in the large and important class of carnivora, there are twelve incisors.

Other parts of animals, also, are remarkable for the constancy of these numbers where the development is complete. The same numbers as the above—that is, $12 + 20 = 32$, may be seen to recur in the limbs of the most perfect kinds. At their peripheral terminations they give $4 \times 5 = 20$ fingers and toes. The same numbers are also sometimes beautifully seen in the structures by which the limbs are attached to the axial part of the skeleton when these structures are fully developed, as in some lizards.* And these twenty are connected with the trunk in all the four by three parts (forearm, arm, and hand; thigh, foreleg, and foot), that is twelve parts, making $20 + 12 = 32$ in all. Nay, it might be shown that to all appearance the bones of the limbs (of recent species at least), when each limb is taken by itself, have thirty-two and twelve as their limits in point of number. Thus, in certain reptiles in which the bones of the extremities are very perfectly developed, it is seen that the tarsal bones still consist of two rows of five each, corresponding to the five digits beyond them,† giving—arm or thigh bone, 1; forearm or leg, 2; carpus or tarsus, 10; metacarpus or metatarsus, 5; phalanges $(4 \times 3) + 2 = 14$ —in all, 32. In hooved quadrupeds and birds' wings, on the other hand, these bones are reduced to about 12 in number.

Very interesting it would be to make a study of the subject with a view to see to what extent these numbers shew themselves in the axis of the animals when that axis is constituted by serial repetition, as first in the annulosa and ultimately in the vertebrata. But here the polymorphism, both of the axial elements themselves and of their appendages, according to the use which they serve, makes the investigation difficult and the results uncertain. Thus, insects, which abound to such an extent all the world over, have $\frac{1}{2} = 6$ limbs. Very numerous species of crustacea (lobsters, crabs, &c.) have $\frac{3}{2} = 10$, and so are named decapoda; while the various tribes of arachnida (spiders, mites, &c.) have $\frac{3}{2} = 8$. All vertebrates above the lowest have $\frac{3}{2} = 4$, which in the highest almost part company, as two (legs) and two (arms).

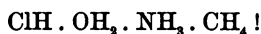
Moreover, it has been ascertained that the number of axial elements or somites in the higher arachnida and crustacea are precisely twenty in number; while in the insects the number never exceeds twenty, as it

* See Huxley's *Manual of Anatomy of Vertebrated Animals*, p. 36. 1871.

† See Professor Owen on the Nature of Limbs, p. 27.

may in the myriapoda. Adding to these twenty, six legs and four wings, and allowing two for generative organs, we obtain thirty-two numerical elements in these exquisite creatures, whose numbers in genera, species, and individuals, are so vast and varied all the world over.

This train of thought might be extended to a great length, and applied to the vegetable as well as the animal kingdom. But naturalists at the present moment are quite indisposed to listen to a doctrine of types, properly so called, or anything that insinuates such a doctrine. If they admit of types at all, their types are merely individuals selected empirically, which appear to possess eminently the features displayed by a large number of individuals. And as to chemists, though they are just as much in favour of types as naturalists are opposed to them, yet their types are merely the quotients of percentages drawn and quartered most cruelly and without any sanction from nature, and so arranged as to be a sort of mockery of an algebraic series, with new constants in every term developed according to the powers of H.



Molecular science, under such a conception of the system of nature, may be compared to that of Botany in 1583, when Cæsalpinus proposed to distribute all herbs according to the number of seeds they bore up to four. Such Procrustian treatment will never do. The dance of nature is not one, two, three, (on the floor of the dead world), and a hop (to carbon in the living world). Molecular nature is as varied and beautiful as crystalline and organic nature. This is indicated by every most minute object which the microscope renders visible.

What will be thought by those who come after us of the science of the present day ! Within the entire sphere of the visible, in mineralogy, in botany, in zoology, in every individualised object which nature produces, symmetry is seen to be a dominant fact, and is duly attended to by the student. But as soon as the objects become so small as to be invisible to our eyes, though they be the very elements of which the visible objects are built up, symmetry is quite forgotten and no regard is paid to it by the chemist ! On the contrary, he ever aims at cutting down his molecular formulæ if he can till the controlling substance remains as one atom only, in which case it never can enter into a symmetrical structure except when it is in the centre. Happily, of late he has often become wiser than he intends to be, and, by mistaking two atoms for one, has constructed many formulæ in harmony with the law of symmetry, and which represent whole molecules, and not half molecules as used to be.

CHAPTER IV.

THE THEORY OF DEVELOPMENT—ITS DEFECTS—THE CONDITIONS OF ITS COMPLETENESS.

THOUGH it be but a little of nature that we have seen in the preceding pages, yet we have seen enough to prepare us for the embarrassment in which many thinking men find themselves when not content with the knowledge of the mere anatomy of an object, as the eye and the fingers can give it, they feel the necessity, in order to intellectual satisfaction, of knowing something as to its antecedents, its cause or origin.

Often, indeed, a beautiful and beneficent design appears in the object, bringing immediate intellectual relief and satisfaction along with it, giving as it does the assurance of the existence of mind at the time of the origination of that object,—mind possessing all those attributes which our own intellectual and moral nature leads us to ascribe to the Author of all.

But this is by no means always the case. Sometimes the object is such that it is difficult to discover design in it at all, or, at any rate, such design as could have originated in a beneficent mind. After much thought, perhaps, its structure or function seems still a stumbling-block in the way of every theodicy.

Of these two aspects of nature, the former presents itself in the morphological discoveries which have been reached in the last chapter. If living matter, when individualised as plant or animal, tends, when not exerting itself, to be contained under a spherical contour, we see here the realisation of a beautiful design—a design that does not rest its evidence upon sentiment, however sufficient for a basis sentiment may be in general, but upon pure mathematics. Thus, living matter is a delicate and tender kind of matter, and of all kinds of matter it is the most precious. Delicate and tender it must unavoidably be, because to be living is to be mobile and easily transformable, yet without being fluid. And plainly it is, of all kinds of matter, the most precious, because to it alone sensibility attaches and enjoyment is possible. It

c

is manifestly important, therefore, that living matter, when partitioned and distributed into small individualised morsels which cannot but be subject to easy destruction by the incident forces to which they must be unavoidably exposed, should be shaped in such a way as would least expose them to laceration or solution, and would retain for them, at the same time, the condition most favourable for the exertion or deployment of that inner force which is implied in the idea of life.

Now, it may be mathematically demonstrated, that both these conditions are most completely fulfilled when the living morsels referred to are shaped into little spheres, meaning by spheres, spherical superficies—such as cells or skins, with their contents. Thus, supposing a sphere to be exposed to incident forces on all sides or in any direction, it is the best of forms to resist such forces: *first*, because being equal and perfect arch all over, it requires the greatest external violence to dent or to deform it; *secondly*, because having a minimum of surface or exposure in relation to its contents, it limits to the smallest number the incident forces which can bear upon it and possibly disturb it; *thirdly*, because all its living parts and particles being so connected together that they are all as near as possible, to one and the same point within it, namely the centre, it may be inferred that they are more fully than is otherwise possible, at the bidding and under the control of the vital force, which is itself in the individual a centralised unity, when the individual is bent in exerting that force. Thus the actual institution in nature of the spherical, as the form of an organism which needs protection in the midst of its environments, and which is also to be capable of dilatation and a full play of its life when its environments are not dangerous to it, is manifestly a most wise and benignant design. It is not merely positively wise, which is generally all that can be affirmed of arrangements that are judged by moral feelings merely. But if the principles of mathematics be the same everywhere, and belong to the intellectual system of the universe, which we cannot doubt, it is superlatively wise. There is no presumption, therefore, in maintaining that it is worthy of adoption by a Perfect Being as a designer of forms for His most tender creatures and their constitutive particles.

Such a satisfactory result is not, however, always, nor indeed even often, easily obtained by the minute observations of nature. When, for instance, calling to mind even the little that has been stated already, we turn from the forms of organisms to the number of their parts, then by all the lights which the actual science of the day, either pure or applied, has to throw upon them, no design, no reason appears why these numbers should be what they actually are; why they should be, for instance, so often as they appear to be, 32, with its dichotomous submultiples 16, 8, 4, 2, and its components 20 + 12, with their dicho-

tomous submultiples 10 and 5 and 6 and 3. There is nothing in these numbers, indeed, which speaks against beneficent design as possibly universal. But neither does beneficent design, nor indeed any design, at first sight at least, appear in them to explain their preference to other numbers, such as 7, 9, 11, 13, 15, 17, 18, 19, &c. They cannot be adduced as antitheistical indications, but they may be affirmed to be not inconsistent with atheism, if atheism be argued on other grounds.

There are other arrangements in nature of such a kind, however, that, in the first impression which they produce, they seem positively antitheistical; as, for instance, the seemingly useless multiplication of organs in the animals near the top of the scale involving great liability to lesion and disease. How can the dyspeptic, in whose stomach his dinner (which, however, he cannot do without) lies like a lump of lead, be prevented from secretly envying the digestion of the *Amœba*, which, without either stomach, or liver, or pancreas, or intestine at all, and merely with a skin which it can turn into a stomach when it is hungry and food comes in the way, digests that food to perfection? What can be the design, it may be asked (in so far as the science of the day is concerned), of such complications both of conservative and of reproductive organisation, as we find around us and possess ourselves, so often in all seeming to our misery?

Often, also, where design appears,—nay, is most exquisitely realised by the most ingenious application of mechanical principles,—how difficult to regard that design as of a beneficent nature! It is not every one who can see a ground of adoration in an exquisitely realised design, all irrespectively of the end for which that design exists. When the Professor of Geology in the University of Dublin shows so well (as he always does) the exquisite muscular and osseous apparatus provided for giving most effective action to the foreleg of the tiger, it is not easy to forget (as he seems to have the happiness to do) the uses so destructive of sentient life for which this mechanism exists.

Nor does this feeling of mystery in nature, when viewed as the work of a beneficent Creator, attach to the contemplation of such objects only as are visible to all. Reference has already been made to the entozoa. To these add the occurrence of parasites generally, and that in the noblest animals, as also the parasitic theory of zymotic diseases which is coming more and more into favour, and it need be no matter of wonder that this aspect of nature, when dwelt upon, should have led even in the popular mind to a great change of view, or at least to great dubiety, as to the origination of nature. Those whose part it would have been to maintain the traditional conception of the theology of childhood, namely, that every individual species of animal originated in a special volition and a direct forthputting of plastic power by the

Author of all, though such a view were tenable from the catechetical side,* do not now enter the discussion in such a way as to secure the attention of men of science; while the latter, as if in revenge upon this view and its inconsiderate assertions, as also in part, perhaps, in revenge for the anathemas which theologians hurl against them, seem to find a pleasure in writing with apparent atheism where, in point of fact, there is neither occasion nor room for anything of the kind.

This is remarkably the case with the theory of development, which is regarded as the triumph of modern times, not only as stated by men of science generally, but by Mr Darwin in particular, as the theory of natural selection, or the survival of the fittest? And here let us call to mind what this theory is, and that not as applicable to plants and animals only, that is, the whole sphere to which alone Mr Darwin applies it, but as it is presented to science by Hæckel, in his "Natural History of Creation," where it is carried up to the "cosmic gas" of the nebula, from which it is supposed that the solar system has resulted.

There is certainly a high intellectual charm when a single idea is proposed for rule, and is made to cover a field so extensive as to space and time. And it is not the subversion of this idea, it is rather its duplication, its completion and its regulation, which appear in these pages.

The theory of development, though seemingly very simple, yet does in reality involve many hypotheses, many complications, and many imperfections. Thus, first, it assumes that while organic species are deducible from each other, transformable into each other, still, from first to last, from the first Monera or germ of Monera, down to the last man, or the last individual of the species that shall come after him, it also assumes that they are all built up of a considerable number of different kinds of matter, such as oxygen, hydrogen, nitrogen, carbon, calcium, phosphorus, &c., there being sixty-four altogether of such material elements in our planet alone! And, accordingly, it admits that these elemental species, unlike the organic species which they constitute, are not deducible from one another; nor are they in any length of time, nor in all eternity, transformable into each other, but radically and inexorably dissimilar. Here, then, is a thorough vitiation of the theory of development as a complete theory. Here is a thorough breakdown in that theory, and that somewhere near its origin. How, then, it may be well asked, is such an incongruity tolerated? To this it is to be answered, that it obtrudes itself in consequence of this fact, and this

* It is strange that such a view should still be maintained by any who stand upon the Bible as the ultimate authority in such matters. In the sacred narrative of the creation, as recorded in Genesis (which certainly every scholar and thinking man, whatever his religious views, must respect), it is expressly said that the command was given to the earth, to the waters, to bring forth.

fact alone, that the chemist in his laboratory cannot succeed in decomposing these sixty-four substances. Hence it is inferred that they are essentially undecomposable, simple, and untransformable! And on this hypothesis the whole science of mineral geology proceeds. But when it is considered that all of these chemical atoms, before they have come into the chemist's hands at all, have been secularly consolidated and mineralised, so as to be able to withstand the ordeal of the volcano and the central heat, compared with which the most powerful analytic agencies of the laboratory are but a mimicry, is it for a moment to be supposed, although their internal structure were still molecular, that they would break down in the chemist's hands? Surely all his containing vessels, which are but things of human art, must go to pieces before them. Nay, surely his own eyes, which are very tender structures, must first be put out. According to views implied in our molecular morphology, the decomposition even of a small quantity of hydrogen, if it were possible, would be accompanied by a tremendous explosion.

Here, at any rate, is there not a great fault in the theory of development considered as a philosophical conception? One-half of it is contradicted by the other half. In so far as the visible forms of plants and animals are concerned, it derives the more complicated from such as are more simple, proposing ultimately to derive all from one kind of germ. But the particles which constitute that germ it regards as having been for ever the same as they are now—some out of sixty-four intransmutable atomic species, varying in atomic weight from 1 to 206 in this planet alone! It extends the doctrine of development and transmutation to species which happen to be visible to such eyes as we have, it denies it to such as happen to be invisible to us. Now surely, in the mere capacity of giving a picture on the human retina, there is nothing to indicate such a complete change in the economy of nature. If all animals and plants have been obtained by the secular synthesis of transformed Monera, and the differentiation of the organs composed of them, thus giving in the last analysis one form and kind of protoplasm as the root of all, the pursuit of the same line of thought, the same theory applied to the atoms of the chemist, with their various properties and atomic weights, gives, as the common ground of all, a single material element, each chemical atom being a structure composed of this material element, but so stable as to be indecomposable in the laboratory. Let this be granted, and the theory of evolution, whatever may be the case as to its cogency, at least possesses a scientific form. It is no longer, as it is now, a conception which breaks down midway between its first and its last terms. Meantime, however, let it not be inferred that what has now been stated is really against it when it is true to its own name, and is itself fully developed. As we proceed we

find, by the most convincing evidence, that this unity and identity of the material element in the last analysis is actually the case.

But letting science in this respect stand for the present as it is, and supposing all the sixty-four atoms of the laboratory, or rather, perhaps, some very high multiple of this number, to constitute that cosmic gas from which the solar system has been evolved, the theory of development shows itself to be as imperfect on the great scale and in point of extent as it has been shown to be in point of homogeneity in its intimate material. Beyond that cosmic gas there certainly is the æther, a medium, which no longer can be ignored in any physical theory of nature. What, then, is the relation of the cosmic gas to the æther? Of that, so far as I am aware, nothing is affirmed by evolutionists. It is obvious, however, that to render the whole system of thought homogeneous, it would need to be shown that all the phenomena of material nature may be explained by supposing that just as all organisms are the synthetic developments of one kind of Monera, and all chemical atoms and molecules the synthetic development of one kind of material element, so is the material element a synthetic development of ætherial elements. And that it is so is shown in this work, so far as it has been found necessary to prove convincing to the author.

But having reached the æther, is the theory of development now fully extended and as all-embracing as it ought to be? Plainly not. Reason cannot rest in the conception of a congeries of particles which are wholly blind and devoid of feeling and thought, diffused throughout all space, believing such particles to be the first of things. Reason, if it is to enjoy intellectual repose, "a Sabbath for thought," which it tends to keep holy, can have it only in finding, beyond and above all things else, an unity, a power, intelligence, personality—in one word, God. This is the only legitimate haven of a theory of development.

And that from Him, as the Author of all, nature may be reached with those very features which it is seen to possess, it is the aim of the following pages to maintain. This is indeed a very old view, and a view very generally embraced till now. But though nothing has been observed in modern times that seems to conflict with it which was not also observed in ancient times, yet respected names in science not only decline to accept it, but argue against it. To me it seems essential to every philosophy which shall be in harmony with intelligence, that it shall be based upon an unity. Nor has a philosophy all the claims to intellectual regard which it possibly may have, unless that unity be an intelligent Being. To suppose thought and feeling to wake up for the first time in that which was previously blind and dead, mere matter and force, from all eternity, is to me nothing short of absurd.

CHAPTER V.

THE TRUE PROTOPLASM AND THE COSMICAL LAW.

THAT an Almighty Being, in whom all perfection dwells from all eternity, should call into existence a creation, which viewed in reference to Himself could not but be a finite and therefore an imperfect thing, has to some minds seemed incredible, and to all that exists as substantial reality they assign an existence from eternity. But looking to the question in a less abstract point of view, reason neither imposes nor sanctions such a conclusion.

In the nature of sensibility a sufficient reason appears why existence may have been awarded to a creation, however perfect in Himself the Almighty and Eternal One may be. Thus the well-being of sensibility is happiness; and happiness in comparison with all other things is so precious that to it all other things, in the last analysis, owe all the value which they possess. Whatever may be fixed upon as the chief good, if it be not happiness itself, must receive that title only in consideration of its being a producing cause or a safeguard of happiness. That which is both itself incapable of feeling or of awakening feeling in any other being is quite valueless. But happiness, on the other hand, nay, even the possibility of happiness, mere sensibility, is held to be of such inestimable value that no creature in the possession of its senses parts willingly with its life; and it is a favourite view in the present day with regard to all organised nature, to look to the individuals which compose it as all struggling for existence—a conception implying how precious life is universally felt to be.

Is it overbold to affirm, then, that happiness must stand very high in the regard of a Being who is supremely intelligent, wise, and good? Nay, is not the maintenance or the increase of happiness in a secure manner precisely what is meant by goodness? Must not the Supreme Being, thus, inasmuch as he is supremely good, surely tend to maintain and to increase happiness?

As to Himself, his omnipotence implies that He is from all eternity

supremely happy or ever-blessed; for if He were not, from what we know of the nature and laws of sensibility we know that He would immediately put forth his omnipotence to bring his sensibility into a state of well-being, that is, into a state of happiness.

The Almighty, then, is ever-blessed. But He is also perfectly good. Now, how can his goodness find a field for its manifestation so long as He alone exists? Such is the nature of sensibility that it implies individuality. So long as one only exists only one can be happy. What, then, in these circumstances are we to expect? In answer to this, it at once appears, that by awarding existence to sentient creatures, placing them at the same time in conditions suitable to their well-being, happiness may be increased proportionally to their number, and therefore to all but an infinite extent. Here, then, granting the existence of an Almighty Being who is perfectly good from eternity, do we not see a sufficient occasion for his awarding existence to a creation?

It is, indeed, true that this argument applies to a creation only in so far as it consists of sentient creatures, while with regard to the actual creation it will be said that such creatures form but a very small part of it. Every new day, however, as has been already stated, the progress of scientific discovery shows that the amount of life in our planet both has been from most remote periods, and is now immensely greater than was but lately supposed. When the amount of strata, both in extent and depth, which the microscope shows to consist more or less or entirely of the remains of organisms which once lived on the surface of our planet or in the depths of a primæval ocean, and the geological doctrine of metamorphism are taken into account, it is hard to say, even on the ordinary evidence of induction, as has been shown, what portions of the crust of the earth may not have been originally concreted by living beings. And if the molecular views of this work be accepted, it follows that perhaps all that is individualised and yet non-sentient is of the nature of a falling away, an excretion, or a rejectamentum from an universe of living beings and things.

Let us open, then, with this idea of a creation—(a supposition, it must be admitted, not without good reasons to support it)—*a creation such as to teem with life up to the limits which the conditions of individualised existence in different regions of space will allow.*

And now, what—let us ask—must the material of such a creation be? To this it surely will not be denied that the proper answer is PROTOPLASM! This is the substance which above all others excites the wonder and admiration of the scientific biologist of the present day, and on which he is disposed to devolve all biological phenomena. Let us, then, ere we proceed farther, pay our homage to protoplasm. But at the same time let us view our protoplasm, not in its chemical but in its

formal and functional characteristics. As to the chemical composition of protoplasm commonly so-called, it consists of a variety of those particles which still defy the analytical processes of the chemist, and which he is disposed to regard as elements, but which, as we have seen, when viewed as primordial and untransformable, do not fall in with the theory of development at all. The protoplasm of the biologist is also a substance which is more or less opaque or visible. The protoplasm which we now conceive as the material of the whole creation in its first state, when development is to begin, must, on the contrary, be altogether homogeneous, and doubtless perfectly hyaline or invisible also. But none the less must it be well entitled to the name of protoplasm, nay, it alone must be justly entitled to that name; for it is the first of created things, and being the product of an Almighty Being it must be altogether plastic in his hands. It can have no constitution of its own derived from itself. Both externally and internally it must be what Timæus calls, *αμορφον δὲ καθ' αὐτὸν καὶ ἀσχημάτιστον, δεχομένην δὲ πᾶσαν μορφάν*, and what Moses calls *תָּרוֹו וְכֹרֶו*. And to these conceptions I shall add nothing by way of description; for there is no use in attempting to conceive it as if it alone existed. For however negative in itself of all properties except being or substance, yet the almighty and ever-living Creator is at all times and everywhere imminent to it, and bears upon it, as the material provided by Himself for the manifestation of his wisdom, his power, and his goodness. It must, therefore, possess specific properties though not aboriginally its own. It must, so far as the finite can with respect to the infinite, unless prevented by Him, reflect, represent, embody, and body forth his attributes and Being.

This the Creator may of course, in the exercise of his omnipotence, prevent, limit, or regulate altogether according to his will, so that in successive epochs in all space, or possibly during the same epoch in different regions of space, there may be in all but infinite variety of creations or worlds differing from each other more or less in their structure and economy. But, in the absence of such limiting volitions, must not the created substance embody or body forth the Creator's attributes and being so far as it is competent for the finite and the created to do so? This must be admitted and remembered. Still, however, as will appear more fully hereafter—but I may state now—there is a limitation to this. Certain properties and demands with regard to that which exists with limited extension in space are inexorable. Even Omnipotence cannot alter them. Beautifully, therefore, does the Doric tract ascribed to Timæus Locrus say, "There are two causes of all things—*mind*, namely, the cause of those which are produced according to intelligence; and *necessity*, the cause of those which are produced by force according to the dynamics of bodies. Of these, the former is essentially

good, is named God, and is the principle of all that is best. In the latter necessity reigns."

Still, with such limitations the primal substance of creation must surely be fully obedient or assimilated to the Creator, and that not in a transient manner, but abidingly or permanently. In its nature the primal substance, the true protoplasm, must be an assimilative substance.

Here, then, let us take that step which, though it may not have in this place the sanction of an unquestionable deduction, yet comes out so fully afterwards that I have no doubt about it, and feel it to be important to state it here. It is to the effect that, supposing this our protoplasm to be partitioned into individualities, then each and all of these individualised beings and things would, up to the full measure of their capacity, not only tend to assimilate themselves to the ever-present Being to whom they owe their own being, but they would tend also to assimilate themselves each to itself with respect both to space and time; as also, they would all tend to assimilate one another. Now, this is our cosmical mode of action or law; and on the strength of this law alone, without invoking the aid of any other, we pretend to explain all those phenomena to which the physicist, the chemist, and the biologist usually address themselves.

And, here, that this may not seem to the reader merely as an idle boast, and that he may have some idea thus early of the way in which this law applies itself to phenomena, let us in passing adduce some illustrations of its action.

Permanent Properties.—And, first, we may remark that it must impart these, to that which, considered by itself, is destitute of all properties except that of substantial existence. In fact, whatever its first form or its form the first moment of its creation, an object if fully individualised as one and simple must, under the law of assimilation, assimilate itself to itself in the next and in every successive moment, and so on, until its own self-assimilative action is modified by some other action from without. Here, then, we see as a first product of our cosmical law of assimilation, the perpetuation of an original mode of existence and the establishment of permanence of properties, provided the individual object considered be such that it is not subjected to change from within itself by the reciprocally assimilative action upon one another of its own parts or principles.

Permanence of Species.—Here we see also the ground of the well-known fact in nature, namely, the remarkable persistency and permanence of well-constituted species.

Species in Genera.—But it follows also, in virtue of the reciprocal activity of the law of assimilation, that species must be associated as genera. Everything, in a word, that acts from out of itself must tend to inscribe

or mirror itself into everything else, and, therefore, there must be throughout all creation a general harmony and homology.

Such are the first products of the law of assimilation, and let it not be supposed that it is to the material world alone that this cosmical law applies. Let us here adduce some illustrations of its action from the mental or spiritual world.

Perception is the assimilation of the mind as percipient to the object presenting itself, so far as the inner action and situation of the mind permits.

Remembrance is the assimilation of the mind in its present state as a percipient to some former state in which it existed as such.

Reasoning is the mind remembering with exclusion of all ideas save those which are assimilated, and therefore similar to one another, and show themselves to be so.

Imagining is the mind remembering ; either with selection of such ideas as are assimilated to the object which the mind has in view ; or more at random and in that spontaneous play of analysis and synthesis, which actuates the mind as an individualised being in the former case, as a member in a system in the latter case.

Judging is the mind in the exercise of this synthetic or analytic power, reviewing the assimilation, and affirming the similarity complete, or more or less or not at all, of two or possibly more ideas or objects presented to it.

Idea, as the term implies, is an assimilate not physical or material, but such as is proper to mind of some real object, material or mental.

And so on with all our other modes of mental activity, which, when viewed generally, are regarded as our mental faculties. They are all, in so far as they are articulate, and possess a definite mode, truly operations of the cosmical law of assimilation. If it be said that in these examples there is already another law introduced besides the cosmical law of assimilation, namely, that which gives a play of analysis and synthesis, the answer is that this play is not due to another law co-ordinate with the law of assimilation. It is a product of this law operating in a higher sphere, analysis being the human mind in the exercise of its free activity, assimilating itself to the Divine mind in respect of his all-penetrating power or omniscience, and synthesis the same in respect of his all-embracing power or love.

To this, the Divine bearing of the cosmical law upon the human mind, man owes reason also ; and as the return movement of the mind upwards, religion. The only human faculty that is not an illustration of the law, in the same sense as all the others, is our mental liberty or power of choice. And even this is due to the law, though in another sense, for it is the assimilation of the human mind to the Divine mind

in respect of the power and perfect freedom of the latter. Liberty, therefore, is the very ground laid for the image of God in the soul of man.

But to proceed ; in the world of physics, as illustrations of this same law of assimilation, it may be said that—

Attraction is the assimilative action of two or more atoms or masses as to the space they occupy. Nor is it the well-known phenomenon in general only that our cosmical law gives. It gives also the mode or law of the phenomenon when pure and simple, namely, attraction according to the inverse square of the distance. Thus the attraction of any centre, viewed as an energy attaching to that centre equally all around and reaching to an unknown distance (which is the usual conception), must, according to the law of assimilation, be distributed in spherical superficies around the attractive centre, all of which superficies must be in energy assimilated to each other, whatever their radius or distance from the centre. Now, these spherical isodynamic superficies or shells increase in size as the square of the distance from the centre increases. The attractive energy in any points or equal areas in any of them, therefore, must be in the same ratio inversely. Moreover, this deduction explains also the law of all radiant action. Nay, does it not explain that phenomenon of radiant action which seems so strange and which it is yet so necessary to assume in order to be able to explain the polarisation of light and heat, namely, that the excursions of the ætherial atoms are at right angles or transverse to the course of the ray? On the surface of the radiant object they must, according to the view here advanced, vibrate transversely, for they are chained to that surface, and are not free to proceed in the direction of the ray. Commencing transversely, the law of assimilation secures the uniformity of the action throughout. Moreover, independently of the form of the vibration at its origin, this transverse, rectilinear, elliptical, or circular vibration, is necessary in order to construct, as far as possible, the successive spherical superficies or shells which, according to our view, are the type of radiant action.

Inertia is the assimilative action of an atom (or mass compound of such atoms) this moment, in respect of motion or rest, to the state in which it was in these respects the moment before. Nor could any language be more in keeping with that proper to the law of assimilation than that in which the property of inertia is usually described. “If an atom or body be at rest it will continue at rest, and if it be in motion it will continue to move in the same straight line, with the same velocity, until it be disturbed by some force applied from without.” An element of motion being the progress in space to the next point adjacent, it cannot but be an element of a straight line, therefore, under the law of assimilation the whole motion must be rectilinear. But the first element must also be accomplished in a certain element of time, and

under the law of assimilation all equal elements succeeding must be accomplished in equal times. Plainly, therefore, the whole motion must be both rectilinear and uniform. And thus our philosophy presents to us, as a result of a purely scientific analysis and simply as a phenomenon, nay, simply as one of a class of phenomena which material nature everywhere displays, the inertia of matter; to explain which, it has hitherto been usual to invoke the aid of some unknown necessity, or the doctrine of a sufficient reason, or the rotation of the atom, or some hypothesis applying specially to inertia, thus placing it among singularities in nature (of which there are none) nay, sometimes placing it in contradiction with the attraction of matter, while here we see how distinct both properties are, though in perfect harmony as might be expected in the products of one and the same law.

Elasticity is the assimilative action of a form which has been disturbed to the form it had previously to the disturbance, and may be regarded as the inertia of form. It is commonly regarded as a phenomenon of a momentary or transient nature. But this only because of the limits of study imposed on the student in modern times, physics being separated from chemistry, and chemistry from biology. If the student in modern times were allowed to take comprehensive views of nature, as the old Indian and Greek philosophers did, it would have been seen long ago that there is such a thing as secular elasticity, as well as momentary elasticity; and various hypotheses, some of them unworthy of their authors (Pangeneses, for instance), might have been spared.

Heredity, Reversion.—These most notable phenomena are manifestations of the law of assimilation also, being as it were the working of a secular elasticity, developing or reintegrating in a succession of individuals the antecedent forms and structures which gave them birth. It is remarkable that, while to this phenomenon all biology owes its form, and is admitted to do so, yet it is never supposed that the same mode of action extends farther; and the consequence is that, during chemical experiments, seeming anomalies in affinity are being constantly met with. These so-called anomalies owe their existence to the tendency of the atom in the laboratory to reintegrate the state in which it had previously existed in nature, and from which the chemist has forced it to depart. Hence the reason, for instance, why atoms of silicium when set free from the mass resume two, atoms of aluminium three atoms of oxygen, or something else that will substitute it. The reason why the two minerals, as they occur in nature, are not similar oxides, depends on the different modes of their genesis, given in our Third Part.

Symmetry, culminating in Sphericity or Symmetrical Cellularity.—This is merely the assimilation to the utmost which circumstances admit in the situations of all the parts or particles which compose an individualised

form to some one plane or line, and ultimately to some one point within that form. And here it will at once be affirmed by the reader that the universality of this tendency in material structures is by no means so obvious as in the case of attraction, inertia, and elasticity. And neither it is. The construction of particles, which are at once attractive and the subjects of attraction, into spherical forms, except when the centre of the form is also the centre of attraction, is very difficult. Hence it is to the heavenly bodies, in the first place (whose centres of attraction are also their centres of form), that we must look for the fulfilment of the law of assimilation in this respect. Now, with regard to all the millions of millions that there are of them, it is known that they are all spheres to the full extent that their rotation on their axis will permit. After these, we are obviously to look for the spherical in such acknowledged objects as are very small or light, so that the attraction of the earth or their weight has but little influence upon them; as also in those which have attained to their actual forms in a medium as nearly as possible of the same planetary attractiveness or specific gravity as themselves; in a word, we must look to the individualised objects which present themselves in the field of the microscope. Now, has it not been shown in chapter III. that there spherical forms are most abundant; and, more especially, that every creature when it assumes a state of repose is in that case most spherical; and this as to ova, spores, seeds, buds, &c., &c. And in a word, is it not agreed that the entire constitutive elements, equally of plants and animals before they are modified by aggregation, are spheres or cells? Yes, the number of objects in material nature, the largest, the smallest, which actually attain to the spherical in form, is inconceivably great, far greater than at first sight seems.

That every individualised object, crystal, plant, animal, tends to assume some form of symmetry, is so obvious, that it need not be insisted upon.

And here we may remark, in passing, an instance of what we see so often in creation, and which it is always so gratifying to intelligence to observe, I mean the discovery that a more comprehensive, possibly an all-embracing law, which in itself bears no signature of design, yet is such that when applied, it realises manifold benignant designs. Thus we have reached the sphere as a form for individualised objects simply as the form of culmination under the law of assimilation. It is that form in which all the parts or particles are most fully assimilated in relation to one and the same point within the form, and to one another. Here nothing in particular appears in its favour; but when we view it in reference to sentient or astral nature, we see, as has been already stated, that it is that form which, considered as a protection for itself or tender contents, is the strongest, being arch all round everywhere. It is also that which exposes the smallest extent of surface to stormy or

unfriendly incident forces. Also that which, as a vessel destined to be filled with precious contents (as a brain-case, for instance), has the largest capacity in relation to the space it occupies, and so on. Not without good reason was the sphere looked upon by the ancient geometers as the most perfect of forms, and the regular polyhedra held in favour as steps towards the construction of the sphere; for the sphere may be regarded as that regular polyhedron of which the number of sides is infinite.

Within these limits, the tetrahedron on the one hand and the sphere on the other, it has fallen me to show, that all the completed molecules of nature tend to lie, and would lie but for the peculiar conditions of their genesis and history, and the incident forces which distract them.

Chemical and Electrical Action.—The well-known condition as to substances, in order that a chemical or electrical action may take place between them, is that they be in some respects dissimilar to each other. And what is this condition but that which implies a field for the operation of the law of assimilation? Moreover, it may be shown that in every case, that action has some kind or degree of assimilation as its aim! A hot and a cold body, when presented to each other for mutual action in respect of communicable heat (or the heat of temperature), or two bodies possessing inertia in respect of the motion of translation, or two elastic bodies in respect of their formal vibration, begin immediately to assimilate each other. In like manner, two specifically dissimilar molecules when presented to each other tend to unite and to remain in union, and by so doing are well known to merge their differences in the genesis of a new molecular species, from which the dissimilar properties of the components have disappeared. Also two bodies dissimilar as to electrical state (one positive, as is said, the other negative), when placed in the proper relation soon assimilate each other, merging their electrical differences in the production of a neutral electric state.

It is indeed in electric, and especially in voltaic action, that the influence and the persistence of this law is most remarkably displayed. Thus let two solids, which are in some respects dissimilar to each other in substance, surface, temperature, &c. (resin and fur, smooth glass and roughened glass, zinc and copper, antimony and tellurium), be brought into continuity, and made to bite each other by friction, pressure, difference of temperature, or otherwise, and forthwith a current of force generated in each and representation of it, passes upon the other, and an assimilation of both, more or less successful, commences. Moreover, by providing means by which these dissimilar but assimilative currents of force may circulate, so that each may back itself by a *vis a tergo*, and so strengthen and sustain itself, their existence may be demonstrated even to such eyes as ours (which were, however, given to us

for entirely different purposes than the making of such discoveries ocularly). Thus there has been observed that mode of action on which such names have been bestowed as frictional electricity, the electricity of contact, thermo-electricity, though but little insight has as yet been obtained as to their nature.

But it is when there is a primary difference *as to state* between the bodies placed in relation with each other that the resulting phenomena are most interesting. Those which are truly homologous are far more comprehensive than the term "electrical" covers. Thus let a solid be immersed in any fluid such that action may take place between them, a volatile substance in the æther, a salt in a solvent, a metal in a menstruum, &c., then, as they are different as to state, an assimilative action as to state forthwith commences between them. The fluid assimilates the solid to its own state, the concrete particles separating from one another, and becoming distributed like those of the fluid particles. The solution of the solid by the liquid goes on up to a certain degree, when an equilibrium of assimilative force establishes itself between the two. After this, on a fall of temperature or other cause favourable to solidification, the assimilative action is reversed. The remainder of the solid, or a morsel of some other solid introduced into the solution, becomes a nucleus for action assimilative to it, that is, concretion.

Moreover, the concrete or solid may from the first possess the greatest assimilative power, as for instance, the soil, and by-and-by, the leaf, with respect to certain fluid particles diffused in the earth and in the air. From this there results the vegetable kingdom.

But, for the sake of familiar illustration, let us take the original voltaic cell, say, a zinc and a platinum plate united above by a conducting metallic arch, and beneath by a conducting liquid, such as dilute sulphuric acid, in which the united plates may be immersed.

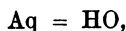
And for the sake of distinctness of conception, and in order to be able to follow the details of the ensuing action, let us suppose that the dilute sulphuric acid employed consists of six atoms of water to each atom of oil of vitriol (monohydrated sulphuric acid), the proportion in which these two elements exist in white vitriol (sulphate of zinc).

Then, on immersing the two dissimilar solids or concretes in the liquid, the assimilative action commences, and since the apparatus is constructed so as to admit of that action taking the form of a closed current, when once begun it may continue; and the reciprocal action is of this nature. (1) The solids or concretes tend to solidify or to concreate the liquid. Meanwhile, (2) the liquid tends to liquefy or dissolve the solids or concretes. And ultimately (3) the persistent or insoluble solids

(the platinum and cell walls) tend to solidify or concrete all. And when they have done their utmost in this way, the assimilative action is then consummated and ceases.

How one solid, as for instance copper or platinum, comes to be less assimilable to a liquid, such as our menstruum, than another, such as zinc, cannot be here stated. Such differences depend on differences in the form and structure of molecules not generally known, and in the case of platinum not known at all. But it is enough for our present purpose to know that one of the concretes in our couple is assimilable or soluble by our dilute acid, while the other is not. And now as to details.

First, on immersion in the menstruum of the dissimilar solids, which, being united by a conducting arch of the same nature as themselves, may be regarded, in the first instance, as one solid consisting of dissimilar particles, such as exists molecularly in a rod or plate of commercial zinc, let us ask, What are we immediately under the law of assimilation to expect? To this it is to be answered, that the liquid part of the apparatus being the most mobile, or the most easily changed, what we are to expect is this, the induction of a tendency to concretion, and consequently a state of tension, in so much of the liquid part of the apparatus adjacent to the concrete part as the assimilative influence of the latter can effect. Hence, if it be possible, there will be a complete concretion of the liquid or of its materials dissociated, in the two strata contiguous to the one or the two concretes. Now, though we do not possess such insight into the molecular structure in detail of dilute sulphuric acid as to be able to picture to ourselves the change induced, when from a natural state it is brought in this way into a state of tension, yet this is known that at the one concrete (the zinc) there tends to form a stratum of oxygen, and that at the other concrete there tends to form a stratum of hydrogen; oxygen and hydrogen being what may be called the non-liquid elements of water, or the terms in which moisture assimilates itself to concretes according to the equation—



which is by no means the statement of an identity as is commonly supposed.* Here, then, the first phase of assimilative action, which is successful, is on the part of the concretes, the zinc and platinum.

But meantime the liquid is not idle. It is insisting on the assimilation to itself of the solids immersed in it also. In a word, the liquid assimilates to itself, and dissolves into itself the zinc oxide as fast as it forms on the zinc surface. And thus the solidifying action of the zinc surface is not exhausted in securing the fall of one momentary shower of oxygen atoms upon it. The first course of oxidised atoms is immediately

* See A Sketch of a Philosophy, Part III. Chap. IV.

dissolved away or assimilated to the liquid, and the concrete surface is as fit as ever for receiving a second, then a third, and so on by the continuous decomposition of the water. Meanwhile (confining our attention at present to the oxygen alone) the specific impact of each atom of oxygen must, when embodied in the zinc, proceed according to the first law of motion, ever onwards so far as it can; and thus having reached the conducting arch above it, must traverse it, and turn round in it, and down the non-soluble concrete, and push through the liquid, which must admit of its doing so, thus completing the circuit, and thus backing and assisting in their incidence on the zinc, those particles of oxygen which are now tending to fall upon it.

In all this there is nothing, I presume, but what was long ago thought and justly received. The peculiarity which the introducing of the law of assimilation imparts to the old view is this, that this current of force instituted by the oxygen is not merely force in general, of which all that is to be considered is its quantity and direction, but force of which the form of its elements or their formative power is also to be considered, that form or formative power being representative or productive of oxygen. It will, perhaps, be said that such a conception is occult and mysterious. But is it more so than anything else which is adduced as a cause of particular phenomena? Is it more occult and mysterious than what is implied and confessed to be hid under the term electricity, or in the phenomena of heredity, to explain which one of the most gifted men of science of modern times has proposed the hypothesis of pangenesis? Our law of assimilation explains all these phenomena, and without any special hypothesis. And surely it cannot be against it that we meet with it everywhere in nature. On the contrary, something of this kind is precisely what is wanted in order to render natural knowledge as a whole accessible to the student, namely, something to put him in possession from the first of a master-thought which if he carry it along with him will present all nature as a harmony, and explain all that stands in need of explanation. But to return. There tends, then, in the single voltaic trough, in virtue of the assimilative action of the zinc to be a current of force representative of oxygen pulsating from the zinc surface up through the arch, down the non-resolvable conducting solid, and through the resolvable conducting liquid on to the zinc again.

But such an oxygen-formed current must, in virtue of the relation of hydrogen to oxygen, tend to place a corresponding number of atoms of hydrogen in an attitude to meet it. In a word, it must tend to penetrate the liquid which lies between the two metallic plates with threads of non-liquid aqueous matter, threads of which each element is HO instead of Aq. And thus proportional to the intensity and quantity of the projection of atoms of oxygen upon the zinc will be those of hydrogen upon

the copper or platinum, or upon any other concrete diaphragm which may be interposed between the original couple.

Here, then, as matters now stand, we see that the phenomenon consists in a further fulfilment of the law of assimilation. At the surface of one of the plates (zinc) the liquid is assimilating or dissolving one of the concretes. At the surface of the other, the insoluble concrete (platinum) is assimilating or concreting the liquid so far as it can be concreted, it is attaching, detaining, encrusting itself with, hydrogen. (By-and-by, as we shall see, the concretes do more than this, and concrete all the liquid into the crystals of white vitriol.)

Thus the law of assimilation has in no small measure fulfilled its function. But it is the only law of molecular and of physical action generally. Now, therefore, since *the liquid* has filled its stomach with concrete particles, having assimilated the zinc in separate particles in union with its own, and *the solid* has taken out of the liquid a dry surface of hydrogen, having assimilated the liquid to the non-liquefiable, the voltaic action may be expected to abate, and the reciprocal currents to cease and fall into a state of repose. And indeed it is easy to see how this issue must take place mechanically. The coating of hydrogen on the platinum or copper must act like a non-conducting diaphragm or simple break in the circuit. The saturation of the acid also with zinc oxide has deprived the sulphate of zinc liquid of the power of dissolving more zinc oxide. For these reasons it is easily seen that the current must cease; and with these reasons science is usually content. And, being thus both mechanically and chemically sufficient, it will be thought by some that the explanation is sufficient, and that there is no need, nay, no place, for our law. But a complete scientific conception consists of two parts: first, the design or law; and secondly, the mechanism provided to execute or realise the design or law wherever it exists. The habit of looking only to mechanism is the plague and sorrow of the science of our times, which is issuing so sadly in the divorce of science from philosophy.

But we have now to consider, with regard to galvanic apparatus, that it is not molecular repose, it is the continuance of the current, and that as strong and steadily as possible, which the experimenter wants. Hence what he has to do, under our law, is to discover suitable means for clearing the surface of the non-soluble plate of its adhering hydrogen, and for replenishing the liquid with new solvent power or fresh acid. But say that he has succeeded in both these objects somehow, as by brushing and adding fresh acid, has he succeeded in thwarting nature and in keeping up his current? No; the two dissimilar metals standing face to face, though prevented by having to stand at a fixed distance, and by their state of solidified aggregation from merging their differences by mutual fusion into an alloy, yet act through the liquid, and

by means of it they act assimilatively upon each other. In fine, the more mobile zinc surface assimilates to itself the more fixed copper or platinum surface. The latter comes to be coated with zinc. The original dissimilarity in the metallic presentations is thus overcome. The current ceases. With the fulfilment of the law of assimilation molecular repose ensues !

There is great scientific beauty, then, in Daniell's cell. By one stroke it clears the hydrogen from the non-soluble metal, and permanently preserves the original dissimilarity of that metal to the soluble metal, while, at the same time, it adds free acid to the liquid to supply the place of that which is neutralised by being assimilated with the zinc-oxide already.

But if means are not taken to prevent it, while the action is continued, not only are the metallic surfaces assimilated to each other, but in relation to them both as concretes, as also no doubt to the sides and bottom of the cell also ultimately, the whole liquid also is assimilated or concreted when it has cooled, so that it becomes wholly solid, constituting white vitriol or sulphate of zinc, of which nearly half the weight consists of water in some concrete state.

So much for electricity as an illustration of the law of assimilation. The phenomena of chemical affinity illustrate that law no less. In this sphere, and simply in virtue of that law, two dissimilar molecules when they meet tend to assimilate each other, and as the readiest way, rush together, merging their differences in the genesis of a new molecular species, in which the nuclei of the constituent elements may indeed be permanently dissimilar, but their temperatures and their ætherial atmospheres become confluent and assimilated.

Hence, all separable atoms and molecules viewed overhead are either prolate, axial, or positive in form, or else oblate, equatorial, or negative ; and these tend to unite, whenever they have opportunity, working their way by successive unions as far as possible towards the construction of molecules, which shall be as nearly as possible spherical and homogeneous, that is, assimilated as far as possible in all their parts and particles.

And now, to bring these illustrations of the law of assimilation to a close, let me simply refer to that from which the name is borrowed—that process, namely, by which a living creature grows to its full stature, and its strength is replenished under the exhausting vital action from hour to hour. This process in highly differentiated animals undergoes corresponding differentiations and complication of conditions. In man, for instance, in order to effect it, salivary glands, stomach, liver, pancreas, &c., are required. An *Amœba* requires nothing of the kind, but needs only to wrap itself like a cloak about a particle of food, and forthwith that food is assimilated.

And here the question suggests itself, Why such complications as are met with in these animals which are by general consent placed at the top of the scale? Now, without proposing to answer such a large question here, these two remarks may be made—*first*, Complication seems to be necessary, in order to the segregation of nervous matter and the construction of a myo-neuro-cerebral system, which may be the mother and nurse of a soul or monad of a higher order than the merely material element, and an organism by which the cycle of the economy of material nature may be completed, and made to touch upon the spiritual world again and to contribute to it; *secondly*, Complication considered as differentiation is the condition by which the concrete state can be maintained when the conditions of existence are favourable to the liquefaction or the diffusion of the particles of the concrete. The law of union by dissimilarity, viewed either as a momentary or a sustained act (which is the basis of chemistry), holds good in physiology. In order that an embryo may continue as a concrete thing and grow while immersed and under the immediate assimilated influence of a liquid, as the embryos of all the higher animals are, it must be more and more differentiated. Otherwise it will be sure to be dissolved and vanish. To prevent this, indeed, as far as possible, the fluids in which it grows are already charged with those very substances which its solution would yield, thus reducing the assimilative action of the surrounding liquid to a minimum—all which statements are, however, now made too shortly to be acceptable or even intelligible, but which may yet be left in this state, being not for the present, when the popular demand is all for very light reading, when science is marvellously content with the attainments which it has already made, and when as to the method of science we are all told with more and more confidence every day, that all we can do for the discovery of realities is to go out of doors (leaving the inner man all alone) and to smell the present, comparing its odour with that of the past, and then turning our noses towards the future to follow them. Sensation, we are told, is the alone architect of all trustworthy knowledge, the author, both as to form and substance, of all that is belief-worthy—no such thing as intuition!—reason merely a habit rising from the long-continued use of the organism!

That such a method should be possible, and may seem logical, follows from that universal harmony and homology which our cosmical law imparts to nature. From this it follows that every great fact, such as sensation, may be seen to be reflected, and may be discovered in all things. But to make sensation a basis for an universal method of knowledge, is to rest all knowledge upon an incident—an incident which is in itself unintelligible, until it be lit up by that intelligence which the sensational method denies.

CHAPTER VI.

THE CHARACTERISTIC OF EXISTENCE—SELF-MANIFESTING POWER.

SUCH is the view which we boldly take at the outset, and present to the scientific reader. The Creator being one, and the creation in any one epoch (as, for instance, the present) being one, we admit only one cosmical law, the law of assimilation. If it be asked how possibly out of one law, and such an one, there could arise anything like that endless variety which nature displays, the answer is, that the law operates between two limits, poles or points of assimilation, which are entirely dissimilar, and by two processes simultaneously (analysis and synthesis) which are the opposites of each other. Hence it comes to pass that actual nature is a web in which unity and multiplicity, identity and difference, are everywhere interwoven, and that in such harmony that nature is everywhere beautiful.

The reader will naturally feel that such boldness is offensive; and his feelings we cannot prevent. But we claim as a right that, until he sees more than he has had an opportunity of seeing as yet of our views, he shall suspend his judgment, legitimately asking questions, but not affirming or denying before the time.

And here he may legitimately ask this question, How does the law of assimilation succeed in accomplishing its function when the objects between which it is operating are at a distance from each other in space or in time?

Now, to this the answer is, that it does so simply in virtue of that which we regard as the characteristic of all that exists. And if it be asked what this is, we answer that it is precisely that which the term existence itself expresses. It is the standing-out-ness or self-manifesting power of the object, not merely as anything in general, or as anything different from what it is, but as the very thing that it is. We do not go the length of those who maintain that the whole nature of that which exists is to be perceived, so that an object cannot exist but when it is perceived, its existence being constituted by its being

perceived. Existence we regard not as "idea" merely, but as "force." And that force we regard as essentially self-manifesting, or spontaneously radiant, so to speak, into that which is "idea," if there be a recipient of ideas, or a percipient of ideas, or more generally a percipient within the sphere of its action. This view, as it appears to me, is fully borne out by the information of thought itself as to the nature of existence. I find that I can think away all the other attributes of substance; but immediately I attempt to suppose the existence of that which cannot manifest itself in any way, that which is not perceivable by any percipient however perfect, then to me that vanishes altogether—it ceases to be.

Further, while we thus lay the characteristic of existence in the self-manifesting power of that which exists, we do not prescribe any limits in space as to the extent of this self-manifesting power. Thus, it is one of the most certain facts in physics that every atom of this planet, nay, every atom of the planet Neptune, whose distance from the sun is thirty times as great as our distance, manifests itself to the sun, and every atom of the sun manifests itself to every atom of this planet, not, indeed, as a precept, but as the subject and the object of attraction or motion. Nay, by the aid of the æther (which is the grand medium whereby the self-manifesting power of being is enabled to take effect at a distance when other being is interposed), the fixed stars manifest themselves at our planet, though their distances be inconceivably great. We, therefore, prescribe no limits as to distance, beyond which the self-manifesting power of being may not extend.

But it is to be remarked, that the self-manifestation of a remote being or thing cannot but run the risk of being eclipsed, stifled, and lost, when some other being or thing is interposed between that remote object and the percipient. The magnetisms of the terrestrial poles do not manifest themselves to a magnetic needle in the hold of an iron ship. Neither does any distant object manifest itself to the mind of man, unless the intervening æther, the eye, and the optic nerve are acting so as to be transparent, that is, as if they were not interposed. Wherever, in short, substance intervenes, then, in order that the self-manifesting power of that substance may not eclipse that of more remote objects, as, for instance, in order that we may see distant objects, the intervening objects, the æther, the eye, and the optic nerve, &c., must be thrown into such a rhythm as that they shall not intercept the self-manifesting power of the distant objects attended to. Now for this the law of assimilation makes provision.

Distant objects, acting like all objects assimilatively, assimilate the intervening æther and the optic apparatus to themselves, and thus render themselves perceivable. This they do, indeed, only under great limita-

tions imposed by the laws of inertia or motion in space, to which the æther is subject,—limitations which, in man, it requires self-teaching and experience to remove, so that he may perceive the object in its true forms and dimensions.

But this is only man's peculiarity, in consequence of his organic defects at birth, and for a long time thereafter. Those animated creatures which are fit for mature actions at their birth catch the true forms and nature of things at once. They perceive them correctly at once. The chick, for instance, which the day it leaves the egg can leave the cover of its mother's wing, can also run up with the greatest precision to a crumb of bread or to an ant's egg at a distance. And so with all species whose myo-neuro-cerebral system functions perfectly from their birth.

Psychologists, by investigating the phenomenon of perception wholly and solely by the study of a species (man) which is blind and idiotic at birth, and which chips the shells of ignorance of all things only with difficulty and slowly, have necessarily found the theory of perception an almost or altogether insoluble problem. Moreover, even at his best, the embodied mind in man sees objects only very defectively, not wholly as they really are, but only in those few lines proceeding from their surfaces which the laws of inertia permit to be established in the æther,—more shortly, sees them only in perspective. Still, in seeing the perspective of objects, we also see the objects, and that under uniform law. And in virtue of this, it becomes easy, especially when the aid of the sense of touch can be invoked to supply the defects of the eye, to attain to a true perception—such a perception as it belongs to the self-manifesting power of the object to impart at once, were it not for the self-manifesting and, consequently, the eclipsing power of the objects that come in between the object perceived and the mind's eye.

Perhaps, in order to secure a fair hearing, this theory of perception, which is, however, simply a justification of the inexorable affirmations of common sense, would need to be enlarged upon more in this place. But, instead of that, in order to get over the ground still before us, I will only beg the reader not to think either of the percipient or of the object perceived as a point, or an aggregate of points merely, in some determinate positions in space. No doubt, every force has a centre of action ; but as to the full extent in space of an unit of natural force as an agent of one kind or another, no limits can be assigned. Consciousness is, no doubt, in the region of the brain. But who shall tell us the boundary in the outward of that power which says I will, I feel, I see? Its modes of acting mechanically are, no doubt, limited to the extent of the investing organism. Nay, in order to their extending even so far, it is necessary that the unity of the organism be maintained by the healthy integrity of the nervous system. In that case consciousness

claims all the organism as its domain ; and not only when the organism is entire does it refer any pain that arises to the region that is hurt, but after a limb has been amputated, and, when it exists only as a phantom, consciousness still feels towards it as if it were still the old reality. Such is the sustained effect of the previous training of the cerebral part of the nerves which still form part of the unity of the organism--such is the effect of habit, in short, or present assimilation to previous practice. But how far beyond the visible and tangible parts of the body the mind, as a power exerting some kind of action or other, extends, cannot be determined.

And the same of other natural agents and agencies. They have centres of being and of action, but to assign the boundaries of their being and action outwardly is not possible.

Meantime, we conclude that the characteristic of that which exists is this, that it can manifest itself outwardly in some way, as for instance to a percipient as that which is perceivable.

If it be asked more particularly, what is the nature of this self-manifesting power, and what are its effects, it might be reasonably answered that these things need not be determined here, since it is only the existence of the power that is insisted upon. I need not refrain from admitting, however, that our cosmical law, the law of assimilation, must determine, if not the nature, at least the mode of action of this force, for plainly that action must be assimilative. And that it is so, when giving rise to perception, is clearly and distinctly seen ; for what is the perceiving of an object, but the mind, as a percipient, assimilating itself to that object ? and what is the percept or remembrance of the object which remains in the mind but the idea, that is, the assimilated symbol of the object, which, however, in consequence of the intrusion in the perception of the mind's own activity and of other previously acquired ideas, as also the perspective image, is often very defective as a representation of the reality perceived ?

Nay, we may say that this self-manifesting power, which is thus the characteristic of all that exists, is the agency provided whereby the cosmical law of assimilation shall be realised. Let us only add, that as to the intimate nature of that agency it is wholly inscrutable. Nor can it be said to be physical until it is embodied in the æther. In that case it is rhythmical, or undulatory, and formally representative of the object whence it emanates ; but with this we have nothing to do as yet.

For the purposes of founding a philosophy, it is not necessary that we should know this. It is enough that we should know that the most intimate and ultimate property, the characteristic, in short, of that which exists, is self-manifesting power. Anything more than this it is not necessary to affirm, nor is it safe, perhaps, if the affirmation is to

apply to all kinds of existences whatsoever. But it is worthy of remark that the existence of a self-manifesting power in an object implies that that object is itself a power or force, or an aggregate of such. Now this is enough for the purposes of philosophy and science; and we only deceive ourselves when we suppose that we can think of anything that exists and which is not at the same time a force or power.

The habitual use of our senses, the muscular sense especially, and the structure of all those objects which are around us, all of which have both a determinate form, as tested by the eye or the hand, and an exterior and an interior, of the latter of which we generally know little or nothing but that it supports and defines the exterior, betray us into a demand for substance wherever there is existence, nay, a certain kind of solidity or plenum in that portion of space which is occupied by the object, and this we tend to hold as constituting existence and necessary to it. But a substance which is not any kind of power or force, either active or passive, that which can neither do nor suffer anything, is inconceivable by man. When the term substance has any scientific meaning, and is simplified to the utmost, it is precisely power or force viewed as in a statical condition.

Of most things that exist, therefore, if not of all, let us say that they are capable of existing in either of two states, the dynamical and the statical, and that when viewed as dynamical they are *forces* or *powers*, when viewed as statical they are *substances*.

But what we have here to insist upon is, that when we exhaust or think away the properties of existence, the last which vanishes is self-manifesting power in the object which exists, this property being such, that when it vanishes so does the object to which existence was awarded.

At present, indeed, there is a tendency in the popular mind to listen to those who are for excluding everything that belongs to the sphere of pure reason, and who repeat the last words of the Greek philosophy when about to die, namely, that phenomena only are certain, the laws of phenomena being merely generalisations of thought, and therefore phenomena (of mind). And until this phase has exhausted itself again, as it has so often done already, it is only to be wished that those who content themselves with it, would also keep in mind the other part of the sceptical philosophy; and, with regard to all other things but phenomena, suspend the judgment. In our day, unhappily, instead of this suspension, there is generally denial, and hence a lamentable descent in thought towards zero, with regard to all which it is most important for man to believe.

CHAPTER VII.

CONCERNING THAT WHICH CAN MANIFEST ITSELF TO ITSELF. MIND
A WORLD OF SPIRITS. THE REALM OF LIGHT.

THE affirmations of the two last chapters—the law of assimilation as the cosmical law, together with self-manifesting power as the characteristic of Being, or outstandingness as the characteristic of existence—enable us now to reach a primary classification of created objects, which we shall presently see to correspond with that which is known as mind and matter, or rather, let us say, mind and that which is not mind; for there is ground for the apprehension that mind and matter do not include all that exists, and that along with matter æther ought to be considered as something intimately related to matter indeed, but yet not just matter. When the elements of the ætherial medium are regarded as truly and simply material, however small and light they may be, the elasticity and pressure which must be assigned to that medium in order to admit of the velocity of light, are altogether out of the harmony of things, and wholly incredible, especially when confronted with the phenomena and the theory of astronomy. Thus, to justify the velocity of light on the same principles as those of sound, in various material media, the ætherial pressure must be 122,400,000,000 times greater than that of the atmosphere! which is incredible.

But what as to mind? To find what shall be called mind, let us suppose an individualised object which is not an isolated object or an universe to itself, but a member in a system, then, in obedience to what has been stated, that object must be at once self-manifesting and impressed by the other objects around it, and, in being so impressed, assimilated to them more or less.

Now, here a most notable difference among objects may occur. Thus some objects, when compared with the others around them, may be so feebly individualised that they shall be impressed or assimilated and fixed in to their very centres, stereotyped all through; others may be so powerfully individualised, that they may be impressed or assimilated to

others around them as it were on their periphery only, their centres continuing unimpressed or free. Now, in the former case the object which is obviously self-manifesting to other objects, for it is impressed by them, can only be perceivable. But in the latter case, along with this, must it not, at least while it is impressed externally also, be self-manifesting to itself also? But if so, what is this but to be sensitive, percipient, or conscious? To me the affirmative answer seems wholly satisfactory. Quantity or intensity of substance or power in a monad, then, is the condition requisite for feeling and thought. And thus by an immediate co-ordination of our fundamental ideas of self-manifesting power and assimilative action more or less, we reach a distinct conception of mind viewed in relation with that which is not mind.

Nor have I in this deduction introduced any new element into the reasoning. The primeval created substance, the true protoplasm, is still supposed to be homogeneous, capable of feeling, animated by its assimilation to the Everlasting and the Ever-blessed One. I have only supposed that it is partitioned in varying degrees, so that there are in creation some individualised or separate objects or forces, consisting of so small an amount or such weakness of substance, that they are wholly fixed and merely perceivable; while there are others consisting of so much more that they are free in their inner life, and have power to perceive themselves also—not, indeed, in the centres of their being, and as unimpressed and without ideas, but as members in a system, impressed or assimilated by other objects, and so having ideas, with power to look in this direction or that, and to act accordingly.

Such, then, according to our philosophy, is the nature of a mind or a spirit. It is a being so constituted as to be at once in possession of ideas, and so far fixed, and also in possession of undetermined life or activity, and so far free. These are, as it were, the opposite poles of its being, and the conditions of its activity. If either is wanting, the other vanishes. Without something fixed in the mind, some object of thought or feeling, there can be no thinking or feeling. Without something unfixed, there can be nothing to think or to feel with; much less can there be any thinking or feeling of self, that is, self-consciousness. But grant this condition in the individual, and add the law of assimilation operating first from God above, thus giving reason and conscience, on the higher aspect of our being, and, secondly, from nature around, thus giving observation and instincts harmonious with our situation in the system of the universe, and then human nature emerges.

But human nature plainly belongs to the last day of the work of Creation, rather than the first, where we are now. In man, to all appearance, the organism is the mother and nurse of the spirit. And though the assimilative action of the mind upon the body becomes

normally, at least, stronger and stronger as life advances, so long as the organisation retains all its perfection, yet, at first, the assimilative action of the body upon the mind is almost everything. The infant, the child, is little else but the victim of sensations, that is, of assimilations in its mind, effected by the force of external nature including the organism itself. But as the mind, through the sustained action towards the focus of the myo-neuro-cerebral system, which is in the brain, gains quantity or intensity, in one word, energy, it becomes more independent and free, and more able to react out of itself upon the organism in any direction of which it makes choice. But of these things hereafter. (See also Part I. Chap. III.)

What it falls to us to recognise, then, as the first fruits of the creation, such as we have now conceived it, is a world of spirits, the immediate creations of the Ever-blessed One, with no bar between his will and their happiness,—a world constituting a hierarchy, at the summit of which are spirits of the highest order and greatest energy, and at the base, such that they are merely capable of enjoyment, and of no other feeling, save possibly suffering, which is the safeguard of enjoyment.

If it be asked, why a hierarchy, and not all of the same order, all on the same level as the law of assimilation would seem to dictate, the answer is, that, no doubt, we are to expect the whole creation, from first to last, to be in harmony with the law of assimilation; but that law, in its primary manifestation, is not merely the assimilation of all objects to one another, but also their assimilation to the Creator so far as the finite can be assimilated to the infinite. Now, in the infinite, there are two attributes which, to use the language of physics, are, as it were, the opposite poles of his Being, and these (nothing preventing) will impart to his creation the greatest possible variety, while, at the same time, the identity of his being secures analogy and homology in the midst of that variety. These two attributes are the Divine unity on the one hand, and the Divine immensity on the other. And a world of spirits, bearing in its constitution the impress of these two attributes, or assimilated to them, must be a hierarchy, giving, most immediately around the throne of the Eternal, spirits of the highest order compatible with a finite nature, then other spirits increasing in number of individuals as each individual decreases in spiritual power, until those are reached who are possessed of sensibility merely, and can only enjoy or suffer.

And here the question occurs, why should not the partitionment of the true protoplasm, the primal material of creation, why should not the institution of many, instead of one, have been brought to a close before the individual had become so feeble as to be impressible merely, and no longer capable of feeling or of reacting from within itself? The answer is, that the immensity of the Creator, his presence in all space

implies, if the law of assimilation is still to continue as the expression of his will, that the created substance shall be diffused to the utmost so as to fill, as far as possible, the whole of space. Now, that substance cannot but be finite in quantity. In being diffused, therefore, to the utmost, it cannot but be attenuated to the utmost. Each particle or element of it must be next to nothing, and cannot but be incapable of any feeling or perception. When the amount of enjoyment in creation has been made a maximum, as is supposed in the question, the primary end of creation has, indeed, been attained; and, therefore, looking to special volitions in the Creator, we might, perhaps, expect a Divine fiat for bringing creation to a close as soon as existence had been awarded to all the possible hierarchy of a spiritual world. But, at the same time, intelligence always expects that the Divine procedure will be in accordance with law, for intelligence itself is a thing of law, and to ascribe to the Deity a volition whose accordance with law does not appear, is to leave intelligence as to that point in the dark. Besides, to assume that if the end of creation was to award existence to creatures who should be capable of enjoyment there ought to be none others in nature, were to assume that individualised objects which had somehow fallen into an apathetic state (as, for instance, by excessive partitionment or attenuation of their substance), could not be recovered or redeemed so as to attain to sensibility again. Now, it is a legitimate inference, that if by an extreme increase of the number of individuals into which a finite quantity of protoplasm has been divided, sensibility has been lost to the individual, then by the confluence again of these same attenuated individuals into unities or monads of more substance and energy, such sensibility should be recovered again. Let us, therefore, take for granted that no stop is put to that development as to individuation which it belongs to the law of assimilation to institute in the primal substances of creation, in virtue of the harmonious bearing upon it of the Divine immensity on the one hand, and the Divine unity on the other. And let us proceed in the same line of thought, and see what we find next. If it prove to be a realm of light as an abode for the spiritual hierarchy which has appeared in this chapter, it cannot be said that in this there is anything in our finding that is out of order. And that there must be such a realm—an universal æther—fully appears.

Thus, in order that the protoplasm of creation may be assimilated as far as possible, and symbolise the Creator in his attributes of immensity, it must, as has been stated, be expanded so as to fill, as far as possible, all space. And in order that it may, at the same time, symbolise Him in his unity, it must be distributed in unities or particles; it must not be a continuous medium—a medium as continuous as possible, no doubt, yet a medium constituted by discrete elements.

Now, it is to be remembered that the primordial substance of creation is finite in quantity. In being all but infinitely expanded, therefore, it must, at the same time, be all but infinitely attenuated. Its self-manifesting power must be reduced to a minimum, that is, it must possess a maximum of transparency and impalpability and seeming non-existence. We need not wonder, therefore, that though such a medium should actually exist, its existence should often be denied. For man's rough way of philosophising is usually expressed in the saying, that "seeing is believing,"—the eye-sight, its focus adjusted so as to enable us to select our food when it is within arm's-length, is made the test and criterion of universal existence!

Further, of such a medium the intrinsic assimilative power of the individualised elements which constitute it must be a minimum. It may be expected that they shall manifest assimilative action only in the lowest degree, that is, they shall possess only the capacity of being assimilated to other objects, and not of assimilating other objects to themselves. This medium must therefore be altogether fitted for representing the other objects which are bathed in it or repose in it, and for carrying out the assimilative action of these objects to a distance.

Moreover, the inertia of the individual elements and of the medium as a whole must be a minimum. When, therefore, two or more objects in space, in virtue of their self-manifesting power, tend to manifest themselves to each other, which would, it may be presumed but for intervening objects, be accomplished in a moment, the delay caused by the putting in motion the particles of this most transparent impalpable attenuated medium will be a minimum. In a word, the velocity of action in it must be a maximum. And, as to the state of mind which this medium, when thus acting between an external object and a mind, should awake, what could we suppose that would express it so well as the gentle sensation of colour carried out on the wings of the belief which the manifestation of the external object awakes in its existence, and instantly applied to the object, so that that object is said to be coloured. This ascription of colour to the object is not altogether a mistake, as overbold psychologists insist. Colour is of course in the mind only, but so are all other kinds of knowledge. To speak of knowing things in themselves, meaning by this somehow otherwise than in terms of knowledge, is self-contradictory and absurd. Colour, though a more obscure idea than form or motion, is yet a phenomenon of the same order, and is just as legitimately referred to the external object which displays it, meaning by external object something external to the consciousness. Colour is all that we can have in our embodied state as a substitute for a clear and distinct perception of that beautiful dance of the æthereal elements by which the self-manifesting power of an external object

reaches the mind. Whether we could possibly have both a clear sight of that dance, and the beauty of the colour at the same time, is an interesting question. I apprehend that we could not. In this it may be thought there would be a loss of enjoyment, and so perhaps there would, but not upon the whole. That loss would be balanced by a gain of enjoyment of a higher order, not in this case only, but in other cases also. For the same reason also (the transformation of mere sensation or emotion into intellectual contemplation), if one could see the structure and intimate action of a neuralgic nerve, the pain would, I apprehend, vanish, the sufferer escaping to behold it as it were from the outside. Yes, the Indian philosophers appear to be in the right when they affirm that all suffering arises from ignorance.

But to return. From what has been said in our pursuit of creation by cosmical law, what we obtain in one grand movement is *a world of spirits dwelling in light with the great Creator in and over all*. In losing thought and feeling, when the created substance is diffused in space to the utmost, we have gained light and colours. In there being no more spirits there has been provided a congenial home for those that are. And nothing, so far, in the whole economy of creation as yet appears to forbid the universal prevalence of enjoyment in all those forms which are proper to adoration, self-knowledge, and a heavenly sociality.

Nevertheless already, as soon indeed as existence was permitted to things unconscious (though, imitating astronomers who speak of the bright specks seen in resolved nebulae as star-dust, we should call them by some such name as spirit-dust), as soon, in short, as the ætherial elements come in among spirits to fill up the amplitude of space, error became possible, nay inevitable. For the law of assimilation, taking effect in a medium consisting of elements which possess inertia, and which therefore constrain motion to be ever as rectilinear as possible, must tend to reduce a true perception of things as they are, to a perception of things in perceptive only, and thus to substitute for a true perception of them a mere projection of them, which is but a shadow or symbol standing in need of being interpreted before the true perception can be reached. This error, however, though inevitable in the child, spontaneously and speedily eliminates itself as life advances. The external perceptions of human creatures tend rapidly to become as adequate as they are at birth in those creatures whose organism functions maturely from the first. There is nothing in the history of thought that is more curious than that the exceptional process of cumulative observation, or experience which is needful in the human species to make the correction of ocular vision, should have been made the basis, and by naturalists as well as by metaphysicians, of our most advanced philosophy.

CHAPTER VIII.

THE MATERIAL ELEMENT—ITS GENESIS AND STRUCTURE, AND NORMAL MODE OF ACTION.

IN what has preceded we have seen the spiritual world owing its being at first to the immediate breath, as it were, of the Creator, then expanding and becoming diffused, as if to emulate the Creator Himself in His immensity, and thus losing itself in constituting the universal æther. As to the actual process of creation, however, all this may have been simultaneous; for the Divine attributes of unity and immensity with ever-blessedness, of which a world of spirits dwelling in light is the image, are simultaneous and from eternity.

But human thought is not capable of the simultaneous at all, and must march in a single file of ideas taking successive steps. In what has preceded, our thought has proceeded from the one to the many, that process which, using the term in its physical sense, is said to constitute analysis. But such a process, being in reality only the half of that of a complete intuition, gives only half views, unless it be followed by its counterpart process, namely, synthesis, which proceeds from multiplicity towards unity, and is constructive of the elements supplied by analysis into unities again. This holds generally; and, as to the matter in hand, we may say shortly that a world of spirits becoming multiple and diffuse, and at last merging into ætherial elements, being now given as the product of the law of assimilation in reference to the *immensity* of the Creator, the same law, when viewed in reference to the *unity* of the Creator, leads us to infer a process of quite a contrary character. It leads us to expect to find the ætherial elements tending to construct unities of greater energy than themselves, and thus to be redeemed so as to recover the spiritual nature.

Now, this synthesis they can accomplish in the first instance by aggregating into groups, each consisting of a number of ætherial elements existing in juxtaposition to each other; for if once a portion of the primal substance of creation has been individualised by the operation of

the cosmical law of assimilation upon it, there is, at the same time, secured to it by that same law, a true individuality which it must tend to conserve with more or less force. Just as in assimilating themselves to the unity of the Creator the portions of the ætherial medium occupying different points in space became each a unity, an individualised particle of æther; so now, as such, it must assimilate itself to itself in every successive moment of its existence and tend to maintain its individuality. When gathering together into a group, therefore, the ætherial elements, in the first instance at least, will aggregate by juxtaposition and not by confluence into larger monads.

And now the question is, will such groups grow indefinitely, or, when they have attained a certain bigness, will anything occur to arrest their growth so that each shall consist of a definite number of ætherial elements? That the latter alternative must represent the case appears from this, that the ætherial element, being but a minimum of elemental force in every respect, must have but a small amount of self-insulative or self-conservative force. Therefore, under a comparatively small pressure centrad, it is to be expected that the innermost ætherial elements in a group will become confluent into a new unity or monad of greater power. And this new unity must be regarded as a being or thing of an order different from that of the ætherial element.

Now, wherever there is such a group of ætherial elements as we are considering, and which, to save words, we may call a nebular speck, there must be a centrad pressure more or less; for under the law of assimilation all the ætherial elements constituting the group must tend to be assimilated as to the space they occupy, that is, they all must tend towards, or press towards the centre. In each such speck, therefore, a confluence of ætherial elements will tend to take place in the centre: a nuclear monad will tend to form.

Can we then, let us ask, determine the quantity of æther which ceases to be æther, and which is restored to the state of a more powerful monad in this nucleus, as also the mode of its genesis, and its structure? If we can, there is every reason to hope that we attain possession of a secret which will explain the structure and numerical elements of natural objects generally; for the law of assimilation leads us to say "ab ovo omnia" in a far wider sense than Harvey conceived; it leads us to expect a homology in the structure, an analogy in the functions of all such portions and regions of nature universally as do truly correspond to each other.

Now, with regard to the form and structure of the nebular speck which we have conceived, this appears, that so far as is consistent with the centrad pressure, which is inevitable, the speck must be spherical and homogeneous. This the law of assimilation demands in reference to

a group consisting of elements which are themselves every way similar, and therefore spherical and homogeneous as the ætherial elements must be. Moreover, it appears also, and for the same reason, that the group of ætherial elements, which constitutes the innermost layer in the spherical group, must also be as spherical as possible, and, at any rate, isometrical.

Now, while various hypothesis and modes of syntheses are legitimate as to the number of ætherial elements implicated in the nucleus, commencing with 4, or an elemental tetrad, and terminating with 2×4 times that number, there are two which the law of symmetry and sphericity, that is, the law of assimilation in its relation to form, present as superior to all others, and therefore to be looked for. They both agree in having 10 ætherial elements in two sets of 5 each for their equatorial region, but they differ in this, that one of them has only one element in each pole, while the other has its polar region filled up by 5 elements for each. In a word, supposing our elastic ætherial elements (all being of equal size) to be so far compressed that they are now bearing upon each other in straight lines, these lines in the one and in the other would defines the following

Geometrical Polyhedrons.



The Dodecahedron.



The Icosahedron.

And here, supposing this to be granted, we are called upon to remark one of the vaticinations of genius. For what was the end and aim of all the labours of the classic geometers of Greece but to be able to demonstrate the properties of the regular polyhedra, of which these two forms are the chief? Moreover, between these two, this among other beautiful relations has been pointed out as existing, namely, that they mutually circumscribe each other in exquisite symmetry, so that either by overlying the other symmetrically gives rise to a composite structure with a double wall, which is far more perfect than either by itself covering as it were the regions in the other which are naked and open to attack.

Now it follows from the law of assimilation (which as to this matter has been long known to be the law of all chemical and electrical

action), that whenever these two, the dodecahedron and the icosahedron, come into each other's neighbourhood, being dissimilar, they must tend to unite and unify. Hence we conclude that a nucleus which may be permanently insulated, and which may be regarded as fully individualised, will most probably consist of 32 ætherial elements unified into one, and be such therefore that, on being resolved, it will give two polyhedra, one consisting of 20, and one of 12 elements or members.

And here let me caution the reader against concluding that this determination is one either of pretended inspiration or of pure imagination, for that there is no evidence in nature as to these numbers and things at all. They have been reached by a survey of nature at first very minute, then more and more general, to which the leisure of a long life has been devoted, till at last it has reached the form of pure geometry. And let the student carry out his studies as he ought to do, if he equal himself at all to the research into the numbers given by chemical analysis and biology, he will find these numbers everywhere manifesting themselves in nature either complete, or, if defective, then by an orderly principle of non-development or abortion. Of these numbers some traces have indeed been given already in our third chapter. If the reader will be pleased to turn back to it he will now so far see the reason of them.

Meantime let him not think the worse of this our radical morphological determination **that I have not put this result as an inductive inference. I might have done so ; and perhaps such clap-trap might have made the thing popular at once.** But I have neither the patience nor the time nor the money necessary for writing the large books which the inductive method requires—books which are, besides, seldom honest. Let us therefore proceed, though in a few words, consenting that they shall be for the future only.

That which we have now obtained, we regard as the material element. It is the product of the centrad pressure in a nebular speck of æther in virtue of which a definite number of ætherial elements become confluent in the centre into one, thus constituting a nucleus of a different nature from that of the uncondensed æther which still surrounds it as an atmosphere, or, as we may say, a dynamosphere, since most of the phenomena of the material element depend on the action of this ætherial atmosphere.

The characteristic which attaches to our nucleus as consisting of a greater amount of substance or force (for, as has been shown, these two terms stand related to each other merely as the statical is related to the dynamical), is that it is competent to observe the law of assimilation in the second degree. The ætherial element itself can observe it only in the first degree ; that is, it can only be assimilated to other beings and

things, and so represent or image other beings or things. It cannot bring itself forward. But this new element can assimilate itself to itself in its most important relations ; that is, in its relations as to space and time, motion and rest ; and therefore if this moment it be at rest, it assimilates itself to itself in this respect the next moment and the next, and so on for ever, and thus remains at rest. If, on the contrary, it be in motion, it assimilates itself to itself in this respect the next moment and the next, and so on for ever, and so it continues for ever accomplishing in every successive moment the same element of motion which it accomplished in the first moment, and therefore it moves uniformly forward in a straight line ; for an element of motion being the progress of one point to the next point adjacent to it, cannot but be an element of a straight line. Now what is this but the well known phenomenon of inertia, which is the acknowledged characteristic of matter ? And such, then, is the principle and nature of inertia in our philosophy. And here I may surely ask the reader whether he has anything else to propose on this head, which has as many claims to intelligent regard ? Our philosophy represents inertia neither as a singular ultimate or unaccountable phenomenon, nor as a merely empirical law, as is commonly done, nor does it invent a ceaseless and universally equally rapid rotation on their axis of all material elements, as has been lately proposed to account for their inertia. Nor does it ignore inertia altogether, as has been still more lately done, throwing back all things into chaos and mystery under the name of force, its laws unknown. Our philosophy merely finds the phenomenon of inertia as one of the thousand consequences of the all-embracing cosmical law of assimilation.

So also as to gravitation. It is the tendency of elements possessing inertia to be assimilated as to the space or place they occupy.

So also as to elasticity or resilience. It is the inertia of form, the tendency of an individualised form, when it has been disturbed, to re-integrate or assimilate itself to its previous form. And here we may remark again in passing, that elasticity, or the restoration or reproduction of form, must render the acting law of assimilation to be secular as well as momentary. And thus, then, are explained also all the phenomena of habit, heredity, atavism, &c.

But elasticity is possessed in perfection only by the material element itself when it is fully invested by its original complement of æther. The material element itself, therefore, is the only species which is wholly intransmutable. And even the material element, in common with every individualised object which has had a genesis and history, must during eternity be liable, under the law of assimilation, to be resolved again into the æther out of which it was constructed. Not but this regressive operation of the cosmical law, this tendency to reversion,

may be met by the unifying and unity-preserving operation of the same law. These two are everywhere co-ordinate, and, in certain cases, either may possibly prevail as the will of God may determine. Nor can the forthputting of that will at any moment or in any region of space be viewed as exceptional or out of the field of science. There is no ground in the nature of things for that contrast of which one hears so much at present under the several designations of the natural and the supernatural. The Divine will is, indeed, now permissive, now imperative. But if by natural is meant that which occurs all independently of His will, either way, then, there is no such thing. Then all is supernatural. Then the economy of nature is one sustained miracle—constant, uniform, and familiar indeed, because the forthputting of the Divine will is one and the same thing with the operation of perfect intelligence, and such intelligence will not vary in its judgment as to what is to be done when the conditions of existence are the same—but still it is all miracle, if by miracle be meant merely the manifestation of Divine agency.

To ascertain the quantity of æther or the number of ætherial elements involved in constituting one complete material element is quite hopeless. But not so hopeless is it to discover the mode of action normal to the ætherial atmosphere, or at least that portion of it which corresponds to the nucleus; and this is more important. And here, happily, there is a familiar electric experiment which will serve to illustrate, though rudely, the normal action proper to the ætherial atmosphere of the material element, when there is no other limitation to its existence but that itself exists, and is called upon to act in a medium which is in some respect dissimilar to the nucleus.

The experiment referred to is that which bears the name of the electric spider, which we may conceive to be thus exhibited. Let there be a metallic ball, standing up from the prime conductor of an electrical machine, and let it be enclosed in the centre of a spherical cage placed in connection with the rubber, and composed of gauze wire or otherwise, so as to allow the spectator to see any action which may take place within. And into this cage let a number of small pith balls be introduced. Then, on exciting the electricity in the usual way, the metallic ball being first rendered dissimilar to the other parts of the apparatus as to electrical state, the pith balls will rush to it, and for a moment adhere to it. But becoming speedily assimilated to it, they will adhere no longer, partly because, in so far as electricity is concerned, they are now entitled to assert independent existence, and partly because, in being assimilated as to electricity to the state of the prime conductor, they are rendered dissimilar to that of the rubber, and consequently to that of the surrounding cage, which is in connection with the rubber.

They will therefore fly off from the ball or nucleus to line the cage or surrounding medium. But then, again, being assimilated there, they will fly back to the ball or nucleus of the apparatus. And similarly from that again back to the periphery; and so on. They will thus maintain a radiant and returning action between the nucleus and the ambient as long as electric difference between them is maintained. Moreover, if we conceive that the metallic ball presents to its atmosphere of pith balls, distributed symmetrically over its surface, twenty regions or points, as also between or beneath these twelve other regions or points, these two sets of points being simultaneously dissimilar as to electrical state, we shall then have twenty and twelve of the pith balls in opposite phases of motion at the same time. Nay, more, in that case we may conceive the cage to be dispensed with altogether, and each pith ball to perform an excursion with return to a point near its origin in the ball or nucleus,—that is, each to perform an orbit which is a very eccentric ellipse, their major axis a continuation of the radii of the central ball or nucleus. Thus would that nucleus be surrounded on all sides by a structure in most rapid motion, more light or ætherial, and more transparent or hyaline than itself. Something of this kind we conceive to be a rude representation of the mode of action of a certain number at least of the ætherial elements which constitute the atmosphere or dynamosphere of our material element. And if this material element thus acting could only be rendered visible, would it not be at once pronounced to be the spore or ovum of some zoophyte or sponge or sea-weed, surrounded by cilia? But let us not anticipate; rather let it not be forgotten that we are now at an incredible distance from everything that is visible. The interior of the white of an egg, under the highest powers of the microscope, is perfectly hyaline, structureless, and invisible, and yet in a single atom of albumine there are certainly not less than 18,000 of the material elements or units of atomic weight, whose structure and normal mode of action when free we are now investigating. The microscope is no doubt an assistance to the naked eye. But the step which it enables us to take in the direction of the intimate and ultimate structure of nature, compared with what is required in order to full insight, is so small as to be scarcely appreciable. The true histology of organisms is one thing, and their microscopic anatomy is another. Nevertheless, as has been already stated, the universal dominion of the cosmical law of assimilation secures a certain amount of homology in structure and of analogy in function universally. And what is seen by the microscope, if accurately observed and rightly interpreted, may be taken as a sample of what exists beneath in the region of the real and the invisible. And if we find that a form and mode of action which, without the slightest

reference to the microscope, or indeed to the use of the senses at all, has presented itself to us as a product of rational deduction from experiment or theory, presents itself also among the first individualised objects visible under the microscope, this is certainly a verification, or at least a good commencement of a verification of our views. No doubt our cosmic protoplasm, being wholly homogenous and undifferentiated, is eminently different from the visible protoplasm of the biologist, which resolves itself on decomposition into oxygen, hydrogen, nitrogen, carbon, &c. But we shall afterwards find that it is the mother and nurse of the latter. And that there should be first a simple and homogenous protoplasm, and afterwards a differentiated protoplasm, heteroplasm, or deutoplasm, or biogenetic substance functioning similarly, but more composite in structure, is just what the homology of nature leads us to expect.

I have stated that our material element, with the rapidly moving particles of its ætherial atmosphere functioning normally, could they be rendered visible in the microscope would be affirmed to be a spore or ovum, completely surrounded by vibratory cilia. To this I may now add, that if, as in entozoa, or in the mass or tissue of an organism, they were so confined or crowded together that there was no room for the play of the cilia, they would then be regarded simply as nucleated cells, that is, as individualised bodies as spherical as their surroundings permit, consisting of a more hyaline or transparent body, and a more opaque nucleus.

In order to obtain the radiant and returning action in the ætherial atmosphere of the material element which has been described, we have supposed that the ambient medium in which the material element exists is simply dissimilar to the nucleus of the material element. Now it is to be remarked, that the action described tends to assimilate as to state the ambient medium and the nucleus; and when the action has been long continued, that assimilation must take place more or less. But of this the result must be a resistance on the part of the ambient medium to the excursions which the ætherial elements tend to make from the nucleus in a radiant manner. And now let us ask what must be the effect of this resistance on the form of their excursions?

Here two cases present themselves. First, the resistance outward may be of the same amount all round the material element, while, at the same time, the force repelling the ætherial elements from the nucleus is also of the same amount all round. Now in such a case it appears that the effect must be to poise the ætherial elements at a certain distance from the nucleus, so as to construct around it an ætherial shell, thus giving an anticipation of a simple cell with a nucleus according to the original conception of it,—that is, with a cell-wall as well as a nucleus and with protoplasm for an upfilling.

Secondly, if the resistance on either side be not in equilibrio all round, then the radial action must be transformed into spiral. And thus, according to our theory, there is introduced into nature that other kind of form which, along with the sphere and the straight filament, appears so early, namely, the spiral or wriggling filament in connection with a mass or head when it is complete, that is, the form of the spermatozoon, &c.

To analyse the action and determine its morphological product in this case is beyond our power. But if the material element be unsupported by others, this wriggling or spiral action must tend to partition it. And if it partition it symmetrically in reference to all the dimensions of space, and in the simplest manner possible, it would break it up into four individualised objects, each with a spiral or wriggling tail, and a head consisting of $\frac{32}{4} = 8$ elements, constituting an unity which might be said to consist of æther on its way to matter. And this may perhaps be admitted to be not a bad ideal of that mysterious element by the development of which the male sex is characterised, and to which such intense interest attaches.

Here, then, we see how an individualised object which has completed itself, and attained to the spherical in form and structure, may continue to exist by partitionment (as also possibly by aggregation), and take a fresh start and commence a new cycle of activity again.

And by considering a combination of the two we obtain a theory of impregnation. The unimpregnated ovule or ovum is a product of most mature action and an eminently spherical structure. It is therefore well suited for repose for any period of time, in the ovary of the parent, or wherever it may have been constructed. But when a form with a defective head and a spiral or wriggling tail (an antherozoon or spermatozoon) comes in the way, as it must tend to do, its form being so dissymmetrical and consequently so active; then these two, the ovum and the impregnating element, being so dissimilar, must tend to unite with force and interpenetrate, and so to disturb the symmetrical and reposing structure of the ovum and introduce a dissymmetrical part instead—a part which must, however, as an ovum continue to mirror the maternal genesis, and as changed by the impregnating matter of the male, must also mirror the paternal genesis, and which, therefore, during that evolution on which its dissymmetry insists must represent both parents.

There is yet another case as to the ambient medium which requires to be taken into account by us. In a word, that medium may be concrete as well as fluid. The material element hitherto free may, for instance, come into contact with the wall of the containing vessel, as a

spore, &c., or may fall to the bottom or adhere to some neighbouring solid. What then, let us ask, will be the mode of action which will ensue in our material element in such a case? To this the answer plainly is, that if the concrete with which it comes into contact be in a similar state with itself it will spring off from it and regain its liberty and normal mode of action again. But if the concrete be in a dissimilar state, then the ciliated or tentaculated form will adhere to it. And the ætherial elements on the side of contact, instead of continuing to play in excursions to and fro, as formerly, will take on the character of root or foot, while those only on the opposite region will continue to act freely. And have we not here the type of the ciliated spore now settled in order to commence development as hydrozoon, sponge, or alga?

Now, while it is developing, the law of symmetry and sphericity, however much resisted by hereditary structure, adhesions or incident forces, must still be operating. As growth and development proceed, therefore (1) a constantly recurring tendency to individuation must manifest itself, the object as it grows must tend to grow multiple or to be a community; and (2) this tendency, when aided by the law of symmetry, may often succeed in disengaging from the growing individual, symmetrical animated portions having the aspect of completed individuals, though not really so. Now of this is there not a beautiful illustration in the production of medusoids? &c. That the same individual should prove to be multiple successively instead of simultaneously, and polymorphous as to type, and in successive epochs of its existence stand still without change of form for a time, the individual thus simulating several individuals of various orders, and exhibiting what has been called "alternate generations," is not wonderful. It is merely a serial manifestation of that variety which nature usually displays simultaneously and co-ordinately.

But here we are postulating growth and development for which the necessity has not yet arisen, nor has any provision been made. Let us not, therefore, proceed in this line any further at present, but rather enquire what functions of animated nature the action of the material element itself prefigures and under the law of assimilation must determine. To find a place for growth we must have a composite body, and not a single material element to start from; and to have development in the systematic or specific sense of the term at least we must have an ancestry of some kind.

CHAPTER IX.

OF ELEMENTAL RESPIRATION AND EXHAUSTION.

THE material element, as it has been conceived in the preceding pages, is, on the principles there advocated, a very perfect thing. It is isometrical in form, and therefore fulfils already the law of symmetry so that no continued action of that law will induce any change upon its form. And yet it is differentiated in structure, so that it is preserved by the law of differentiation (the maintainer of the concrete state) from that tendency to partitionment or dissolution which belongs to the isometrical when it is homogeneous. The material element, therefore, possesses the morphological conditions requisite for its continuance in existence for the greatest length of time.

Still that length of time, however great, can only be a very long time. The material element having had a beginning in time cannot spontaneously exist for eternity. For, whatever its solidarity at the present, or at any moment, a thing which consists of particles which were once discrete, must, under the law of assimilation acting in relation to time, and known as the phenomenon of reversion, be liable to resolution into its primordial elements again. Whenever, in reference to such composite being or thing, an analytical phase of existence prevails over the synthetic, that being or thing must tend to repeat its previous history backwards, and to be resolved into its previous elements.

And so with the material element itself. And in this perhaps there may be the cause of phenomena which are at present a mystery in science. Thus if the analytic phase of action were to overtake the material element suddenly, as by some rapid change of situation or of heat or of electricity, &c., then in the lighting up perhaps for a moment of a speck of phosphorescence with an inaudible explosion, that element would resolve itself into the matter of light again. And if this were to happen on the great scale, in the upper regions in connexion with our globe, then possibly in the absence of sun-light

faint meridional or equatorial lines of light such as those of the Aurora might be seen even by such eyes as we possess. And in the celestial spaces there might possibly be phenomena like those exhibited by comets' tails. If again the analytic phase of action were not sudden but sustained, then there might be expected the slow vaporisation of the nucleus of the material element into æther, having its issue in the complete disappearance of the nucleus. And thus there might be phenomena of which we are reminded when we think of what happens to the nucleus of a comet when near its perihelion, or to a living cell when its function is nearly being completed.

But this case calls for a more special consideration. We have seen that, in all but a single instance, the material element in virtue of its normal action must be subject to a nucleus-attenuating action which must be regarded as quite normal to it. The exceptional case occurs when the medium in which the material element exists is of the same nature as the nucleus of that element. When that is the case, then indeed the ætherial particles constituting the dynamosphere of the material element, after having been charged under the law of assimilation with a material aura by their descent upon the material nucleus and contact with it, and after that descent and contact repelled by it in virtue of having been assimilated to it, will, after having completed an excursion to a certain extent outwards from the nucleus, experience repulsion from the medium beyond also, that being also similar to themselves. And thus they will be balanced there by a repulsion both from the inside and the out, and so they will form a materialised spherical ætherial shell or cell around the nucleus. The material element as to its natural quick action will be brought to a state of repose, and, as we may say, it will be encysted or exist in a state of hybernation. And here are we not called upon to observe the prefiguration of phenomena of the same nature in the animal kingdom, which have indeed been already noticed? But what we have now specially to remark is this, that in this induction of the encysted or hybernating state there is neither new life nor loss to the material element. That element is as strong and is indeed all that it was at first, but it is no stronger nor more. It merely exists in a state of tension representative of the previous action which threw it into that state.

But what if the ambient medium be non-material, which is the fact. In this case plainly the state of tension induced in the material element must be relieved. The particles constituting the shell or cyst of the hybernating or encysted structure being now dissimilar to the medium beyond, will impart their material change to it; and being thus rendered truly ætherial organs themselves, they will descend upon the nucleus whence they had been raised, and the initial state will be

restored. And now receiving from the nucleus a material change again, they will be thrown off as before. Of this charge again being relieved by the non-material medium beyond, they will descend upon the nucleus as before; and so on, fulfilling the reciprocating action which was described in last chapter. Here then we see, looking to this action so far at least as it has been described, that it must be exhaustive of the material character of the nucleus; for every successive excursion of the ætherial elements which constitute the dynamosphere of the material element carries off into the ambient medium a material aura, while nothing of the kind comes down in return. The longer this action continues, therefore, the more must the nucleus of the material element, considered as a materialised organism, be attenuated. In what way this secular attenuation of the nucleus of the material element shall manifest itself it is not easy to discover. It can scarcely be otherwise than in a relaxation of that unity and confluence of the ætherial units constituting the nucleus which makes them to be non-ætherial or material.

But before forming conclusions as to this matter it is necessary to call to mind that the action of the law of assimilation is always reciprocal. If the ætherial elements in their excursions from the nucleus of the material element impart a material charge to the medium or region beyond, that being of necessity such as to be a recipient of such a charge, it is to be remembered that the same elements in their descent upon the nucleus must impart to it in return some kind of equivalent derived from that region beyond. Now, what can this be? It has already appeared that it must be non-material. Is it then merely and purely ætherial? What, if all the æther in the celestial space considered is already appropriated as belonging to the material elements which possibly crowd that region, is there nothing above and beyond, that can help us out of the conception of a broken or half fulfilled law? What is wanted to fulfil that law is the existence of a power or energy above and beyond the æther or medium of light of a non-material nature, or rather of a nature existing in contrast with matter. What then can it be? To call it immaterial or spiritual would be merely to introduce terms which are at present voted to be unscientific. But this is certain, that by whatsoever name it be called, it must be a power or energy, for nought else is conceivable by us as capable of an objective existence. Let us content ourselves then with saying that, in exchange for a series of losses of its materialism, by the unceasingly reciprocating action of the ætherial elements of its dynamosphere, the material element is all the time receiving from beyond and above itself corresponding accessions of non-material energy or power. And with this the mere physicist, if he is determined to continue such, must be contented as a last word. His distribution of the sciences, and his proposed isolation of physics from

all that is above and beyond, calls out "stop" to the train of thought if it ventures on the next word, for that word belongs to the sphere of theology. Nevertheless, let it be stated here that this sustained supply of non-material energy which, it thus appears according to our views, inflows into the material system from above and beyond the ætherial medium or realm of light, is and can be nothing else than the sustained operation of the ever-acting will of the ever-living Creator of all, not in word, but in power, at once natural and supernatural—*natural*, inasmuch as the exclusion of mistakes and of all need for alterations and improvements implied in His perfect intelligence from the first, gives rise to uniformity in phenomena when the conditions of existence are the same along the whole stream of time; *supernatural*, inasmuch as the whole material system is, according to this view, not wholly self-contained and dependent on itself alone—not merely a timepiece inexorably unwinding and winding up itself again mechanically without the possibility of any departure from what was set at the beginning—not a finished web in a show-room, but a web still in hand, still in progress under the eye of the designer. Hence follow the doctrines (1) that there is both a general and a particular providence; (2), that prayer for physical change is not unreasonable, and may be granted without what is commonly called miracle; and (3), that what history records as well-attested miracle may enter into the normal or scientific conception of the material economy.

But to return to the purely physical conceptions of this chapter and the preceding, have we not, let us ask, in the normal reciprocating action of the dynamisphere of the material element, and the continued ascent of something material from its centre or interior to the ambient medium above and beyond, and the descent from that medium towards the centre or interior of the material element of something of an opposite nature—have we not in this, let us ask, a striking prefiguration of the functions of respiration as it actuates the whole animal kingdom and ourselves? Thus an animal, in so far as it consists of living matter, may be regarded as an aggregate of aeriform particles retained in the concrete state by the fixing power of carbon, which is one of the most fixed of all the elements, and as we may say, the most eminently material.* . Considering an animal then as primordially represented by

* Those readers who are acquainted with the previous parts of this work (P. II. p. 67, P. III. p. 74) will grant how suitably among all elemental molecules carbon may be chosen as the representative of what is pre-eminently material, and how curiously an atom of diamond may represent the nucleus of the material element itself, as it has been here conceived. Thus it has been seen that, according to our views, that nucleus consists of thirty-two ætherial elements confluent into one. Our method which enables us to deduce the specific gravity of solids, and when

one material element, the carbon in that animal will represent the nucleus of that element. Moreover, though the animal, as a whole and to the eye, seems a concrete, yet it is well known that in every case of life there is, and in order to life there must be, a sustained interchange of dissimilar particles, one set coming in, as we may say, the other going out—not dissimilar, indeed, when reduced to terms of greatest simplicity. In their ground these particles are both the same. Oxygen is the moving element in both cases, but with this difference, that, when going out from the animal, instead of a merely material aura, which is the charge of the ætherial element when going out from the nucleus in the single material element, the oxygen in this phase of its action, when leaving the respiratory apparatus, is charged with carbon; while previous to its descent again, or the returning phase of action, it has recovered its previous quickness—a quickness which has gained for it such names as vital or empyreal air. It has, in fact, in the meantime deposited its carbon in another medium outside the animal kingdom altogether, giving to nature the vegetable kingdom or adding to it.

Here, then, we are now able to understand fully the necessity of sustained respiration in order to the continuance of animal life. The fact has been known time immemorial. It has also been known for long that respiration removed carbon from the system, and that it was this element which, if left in it, speedily produced death. But it was not known why carbon if thus left should prove so speedily fatal. And here let us state that reason which now appears, as it may sometime hereafter lead to a complete theory of poisons. The function of carbon in the organism is to bolt the aeriforms (common and ammoniacal vapours) together, and so far to fix them as to prevent life from being quite ephemeral. But while it holds some particles, it must let others go, for life implies a continual exchange. To be wholly fixed is to be dead. Carbon, the fixing element, therefore, when in excess in the organism in that state (probably of single atoms) in which it fixes, must make for death, and when in excess in the “*nœud vital*” must destroy life.

But respiration not only carries off the effete and poisoning carbon atoms. In doing so it generates such heat as the renovation of the

that has been ascertained by the balance, to deduce from the experiment the structure of the molecule, leads to the inference that the least atom of diamond consists of just thirty-two atoms of carbon (the same being the case with other fixed or reposing substances, such as gold and silver). Thus forming these atoms of diamond into the usual dodecatomic molecules to bring the unit volume of the substance into relation with the aqueous standard, we obtain—

$$\text{Expt. Diamond G} = 3.55 = \frac{30 \times 32 \times 12}{2 \times 1620} = \frac{\left(\frac{32}{C}\right)^{12}}{2AQ} = 3.55 \text{ Theory.}$$

organism requires. It gives moisture also to the tissues. In a word, it does more for us than can be told.

But it is to be remarked also, that while respiration is a vitalising and an energising process, it cannot but be also an attenuating and an emaciating process. If the concrete state and a certain mass of organism be essential to the well-being of an animal, as we know it is, then respiration brings with it an evil as well as a good, for it is always carrying off matter from the organism. How then, let us ask, is this good retained, while the evil is met and superseded? Plainly the evil will be met, if the matter breathed away by the animal can be reduced to the concrete state again, in such a form that it may feed respiration anew, and thus render this function continuous and circular. Now this is precisely what is done in the economy of nature. The vital or empyreal air of the atmosphere, after having been breathed and charged with the carbon of which it has relieved the animal, and now bearing the expressive name of choke damp, retains so much of the fixing character of carbon and the parasitic nature of oxygen, which are its constituents, that it tends to settle on the surface of the soil and on the foliage of plants, and to give up its carbon there to perform in the vegetable kingdom the same function as it had already performed in the animal kingdom, that is, to fix and to build up into somewhat stable tissues, particles whose cohesion otherwise would be wholly ephemeral at all but the lowest temperatures. Now these vegetable tissues, when not too stable, are such that animals delight in taking them into the interior of their bodies or stomachs, and there they are assimilated to their tissues. Thus is the attenuation inevitably attaching to respiration beautifully remedied. Nor is there any want of vital air to carry life on as before. The breathed air having given up its carbon to the soil or foliage, is now vital air again, and resumes its place in the atmosphere as fit as ever (at least after a dance in the sunbeam), for descending on or into the animal and enabling it to breathe.

Thus is the vegetable kingdom co-ordinate with the animal kingdom, and its complement. The two taken together, with the atmosphere around, and the sunbeam playing upon both, form a complete self-sustaining circle. But the fact that animals and respiration existed before vegetable matter required that animals should be so constructed that they could feed upon each other also; and hence, manifold complications. Moreover, ammoniacal vapour, which is no less essential than common vapour to constitute living tissue, when it encounters loose atoms of carbon, and undergoes decomposition, is not capable of the aeriform state. Hence, to the respiratory system, an ureal system required to be added. In all food also, there are some unassimilable parts, and hence a faecal system was also required. But these facts do not

belong to the intention of the creation; but to the inevitable limitations under which alone any design could be carried out which involved the existence and action of forms and forces in limited portions of space and time. The material element itself is rather a foreseen and a divinely regulated thing, than a freely willed and primary creation. Spirit, that which is capable of thought and feeling, is the original and elect object. Body, that which is wholly apathetic, is rather of the nature of a chemical precipitate in creation, giving grand and beautiful phenomena no doubt, and therefore sanctioned, but still as compared with spirit, only a cloud in the azure.

I cannot conceal from myself how completely these views stand in contrast with all that is currently believed at present by many to whom the name of scientific on the one hand and of religious on the other is accorded; and, of course, I must take kindly the disapprobation of both. How many hold at present that some one dead thing called "matter and force," acting blindly and only mathematically at first, is the sum of all reality—thought and feeling being merely a transient efflorescence of "matter and force" when it has come to exist in a certain state, nervous ganglion, namely! Now, to such a scheme of the universe, the views here advocated stand diametrically opposed, and are indeed its complete inversion and denial. From philosophers of this school, therefore, these views will receive no quarter, and as the kindest treatment will be ignored as long as possible. Nor will they be more congenial to many religious men who simply take for granted, without consideration, that the Divine omnipotence implies power to realise or substantialise immediately and independently every idea be what it may, provided only it be not essentially contradictory or self-destructive. But plainly such a conception of creation, in order to be accurate, requires to be specialised. Existence implies all its conditions. That which is to occupy limited portions of space cannot but have a form of some kind. It must therefore fall under the conditions which the science of form, geometry, imposes. Not that this science is anything that exists absolutely or adversely to the Divine power. On the contrary, in so far as it is true and perfect, geometry is merely the expression of the Divine power acting as intelligence when contemplating limited portions of space and time, that is, when looking into a field which is also its own, and without which it is not possible to conceive how it could be at all; for space is not what an over-keen analysis gives it—a merely subjective phenomenon, a dissolving view. Space is the eternal co-ordinate of the omnipresence of the Deity, objective as well as subjective; and man owes his subjective hold of it, as usual, to the cosmical law of assimilation.

CHAPTER X.

OF ALIMENTATION—ITS MODES AND UNAVOIDABLE LIMITS.

If the material element was brought into existence by a process of development, a process which took time to accomplish, and that, the synthesis of particles which previously existed separate and individualised, then under the cosmical law of assimilation acting as to time, that is, the familiar law of reversion, it must be liable to resolution into its ætherial constituents again. In the preceding chapter, indeed, the function has been shown by which this law will be fulfilled, and by which the material element must tend to repeat its own history backwards, and suffer dissolution—or rather, let us say—be resolved into that more perfect state of being in which it existed previously, namely, pure æther or the matter of light.

But we are not to infer from this that the material universe contains in its own nature the seed of its own extinction. Those ætherial elements which have once entered already into the structure of a material element must, though now existing separately, tend, when the ebbing of the analytic force allows, under the same law of assimilation, to reconstruct a material element again. And thus in different regions of nature the dissolution and the genesis of matter will be concurrent and equivalent, and the quantity of matter or of force in the universe as a whole will be conserved, as Leibnitz long ago maintained, and as modern physicists have made some feeble attempts to demonstrate.

Such, then, is our conception of the material element as to durability. It is naturally very long lived, but it is not naturally everlasting. In fact, already even in the material element itself the periodicity of nature has commenced. In the cosmical law when viewed as acting in time upon that which lives and moves and has its being in time, the dissolution of the body of the individual and its reconstruction or resurrection are already precluded.

We have seen in the last chapter the mode of action—preluding respiration—by which the nucleus or body of the material element is

attenuated or emaciated and brought towards dissolution. And now, let us ask, Does the economy of nature present us with no equivalent action which shall be correspondingly conservative of the individual? While breathing away its substance into the ambient medium, does the economy of nature present no alimentary provision? Yes; this also the same cosmical law provides. As soon as protoplasmic organisms of dissimilar ages, though otherwise identical, come into the same field, those which were there before, and have lived longest in it, must go to those which have been more lately introduced. For in proportion as they have lived longer they have breathed longer, and so been rendered materially weaker than the younger ones. But in being rendered weaker they have at the same time been rendered dissimilar. In virtue of their dissimilarity, therefore, the two will, under the law of assimilation, tend to unite. And the mode of their union must be this, that the weaker shall succumb to the stronger. The stronger shall assimilate the weaker more or less, and so feed upon it. But here three modes of feeding present themselves, which, according as the one or the other takes place, must be productive of very different phenomena in nature.

I. The dissimilarity between the two individuals which leads to their approach, may be such that their union is only a transient concurrence, and results not in their complete reciprocal assimilation and their unification, but in the construction between them of a reciprocally assimilated morsel, ovum or embryo, which ultimately separates and sets up in nature as a representative of both. The feeding in this case is that implied in sexual function.

II. The dissimilarity between the two organisms or cells may be, such that, after having met in juxtaposition, one or other, or both, are no longer capable of maintaining an individualised and separate existence, while yet neither is so powerful, compared with the other, as to assimilate it entirely and absorb it into itself. Hence there result in this case not the genesis of ova and embryos, but the growth, composition, and differentiation of organisms, and in fine, under the laws of morphology, all the variety of species in nature which enter into the original design of the Creator, as embodied in the material element itself.

III. The dissimilarity between the two may be such that the one is powerful enough completely to appropriate the other, to digest, and to assimilate it, adding it in separate particles to its own organism whenever such particles are wanted for reintegrating its organisation, restoring its energy, and rendering its life enjoyable. In this case, then, we have a supply of food and alimentation as commonly understood.

Now, in all this there is, I apprehend, nothing that is calculated to disturb theodicy. On the contrary, is there not very much to admire, and for which all nature, so to speak, should be thankful? This must,

I think, be frankly admitted. But if so, then there is no room for insinuating intellectual or moral dissatisfaction with things as they exist in nature, when nature is regarded in a theistical point of view. There is no room for apprehending or insinuating that nature cannot be the creation of a benevolent Being on account of that struggle for existence which nature undoubtedly displays, and the fine organisation of the carnivora and other feeders on animals. That there should be a struggle for existence, shows that existence is felt to be a desirable thing, or a good, and so far, therefore, the gift of a good Being. And as to feeding upon animals, and no doubt depriving them of their life in doing so, how could it be otherwise, since food must be had, and as yet, according to our conception of nature in its rise, there is nothing but protoplasm or animal matter to feed upon? If it be suggested that some animals might have been made to feed upon other animals without killing them, this is to advocate the substitution of epizoa and entozoa instead of free animal-feeders, which few would be disposed to insist upon as an improvement. If it be asked, why all animals might not have been made to feed upon earth as many worms seem to do, it must be remembered that as yet, when a sentient creation as a maximum had to be designed, there was no place for earth, though it had been possible to make animals such that they could assimilate earth.

But why, it may be said, were not all animals made so as to be vegetable-feeders? To this the answer is, that according to our conception of the cause of creation this was impossible; if creation is to teem with a maximum of sentient life from the first, vegetable life can only be subsequent to animal life. And that it really is so, the actual observation of nature, even in the present epoch of nature, fully verifies. It is quite in vain to look for vegetable food to sustain the animal life with which the depths of the ocean are now known to be carpeted, or infusorial animalcules, or indeed the animal kingdom anywhere in its rise. Besides, the structure of the living vegetable element, the primordial article, shows that it is more highly elaborated than the protoplasmic animal cell. It is as perfect and it has something superadded, namely, a casing of cellulose—an advance in organisation, and a provision which may be compared to the siliceous and calcareous shells superadded to many simple animals. More than this. According to the theory of creation here advocated (which has it not this also in its favour that it gives a very definite relation between the animal and the vegetable kingdoms), material for the construction of a vegetable kingdom does not exist until animals shall have breathed, and lived, and died previously. To give being to a living plant, not only aqueous and ammoniacal vapours, but carbonic acid gas is wanted. And in that golden age of planetary condensation which we build upon, when the “cosmic vapour”

was condensing so gradually that the organic elements only were being constructed out of it, but nothing mineral, or volcanic, or fiery in any way, when, in a word, all was favourable to animal life, it was from animal life alone that carbonic acid gas could be obtained for vegetable life. As to the ammoniacal vapour, which is no less essential, we ascribe to it a direct genesis out of aqueous vapour, as shown hereafter.

Here, let us remember, however, that an epoch of condensation did arrive when the more central parts of our planet became meteoric, volcanic, and fiery, and then no doubt, as now to a certain extent, carbonic acid gas would be generated in a mineral way. But this state of things may still be regarded, not as the triumph of death over life, but rather of life having its revenge upon death; for during this epoch, carbonic acid gas in all probability must have been evolved very abundantly; and to the very extent that this gas was then or is now given to nature, it creates a saving of sentient life; for it goes to construct vegetable matter, and so to supply such food for animals as shall not necessitate the destruction of other animals as food for the survivors.

Very beautiful is the adaptability of carbonic acid gas (along with aqueous matter) for returning to the animal kingdom, to which itself normally and originally belongs, all that the animal kingdom needs for its existence. Having already been concreted, it is under the law of assimilation (reversion), prone to become concrete again, a tendency which on its very discovery gained for it the significant name of "fixed air." When thrown out of animals during their respiration, accordingly, it tends to settle on the ground, or on the foliage which has sprung out of the ground. And there it is parted into its constituents. Its oxygen is restored to the atmosphere to serve for respiration again, while its carbon is taken in to serve as bolt and screw for the particles of aqueous and ammoniacal vapours present where it has been absorbed, which when thus bolted and screwed together constitute vegetable tissue. Now this vegetable tissue does not exist for the sake of its beauty only, though that be so great as to secure universal admiration, nor yet for withdrawing from the atmosphere the products of respiration which, if they had to be breathed again, would prove injurious to animal life. The vegetable tissue is, as has been stated, good for food. That which, if it had been left in the state of "choke damp" diffused in the air, would soon have proved fatal to animal life, is, by being split open and having its oxygen returned to the air, and its carbon fixed in vegetable matter, rendered most valuable to animals both ways. It both supplies air for respiration and food to repair the emaciation which respiration unavoidably implies!

And thus a benignant economy in favour of sentient life appears. At first animals must destroy animals for food, for food is indispensable,

and there is none other as yet but animal food to be had. But as the animal lives and breathes (which are the same) it puts forth leaves, not on its own body, but elsewhere in situations more convenient for bed and board as well as shelter. And the more there is of breathing or animal life in nature, the more there tends to be of foliage, to produce which, moreover, the expiration of the volcano co-operates with that of the animal.

The course of nature, therefore, as to alimentation is this, that while at first carnivorous practice in animals is inevitable, yet these very animals, by subsisting on animal food, give birth to vegetable food, which thus tends to increase in supply as the ages roll on. Thus, in the limit, what we foresee throughout the entire zoological scale are vegetable feeders only, all destroyers of sentient beings having vanished.

The real struggle for existence then, when the economy of organisation is regarded in the largest point of view, is between two orders of beings, which we may respectively designate the lung and the leaf—a friendly struggle in which the destructive defeat of one is in reality the signal victory to both, the leaf in yielding to the lung, affording it “bed and board, coal and candle,” and phoenix-like, speedily arising again from its own ashes, more beautiful than ever.

But why, it may be asked, this round-about method of alimentation? Why these long, long ages, before animal life shall exist in harmony with the laws of sensibility and the dictates of perfect beneficence? Why has it not been arranged that the products of respiration shall serve for food directly and at once? In answer to such a conception, it were easy to show that it violates the law of the conservation of energy. It is to ask that an animal shall be a perpetual motion. Now, if an animal were itself an universe, or a completely individualised and insulated being or thing, so placed and constituted that all the energy which actuated it returned into itself, this were possible. But for no thing whatever, that is a member in a system, is a perpetual motion possible except as a current passing through it. In order to the maintenance, and still more the increase of life in nature, not only is the leaf necessary as well as the lung, but these two must be placed in a definite relation to one another. Neither can that relation be of the simplest kind. It would not do merely to dissolve the leaf in the same medium as that in which the lung breathes, and leave the alimentary particles to be absorbed by the lung generally, whenever they came in contact with it. This would be merely to surround the lung with the products of respiration, and so to clog and destroy respiration. But let the leaf be dissolved in another medium than that of respiration; let it be dissolved in water, for instance, which is at the same time permeated by air fit for respiration, and then the lung (or respiring organism) existing in

this water, may both breathe in virtue of the oxygen in it, and be fed in virtue of the dissolved leaf-particles in it, and that possibly by a peripheral absorption, either partial or general. In this way, then, by differentiating the medium around it, a very simple organism may lead the life of an animal. Thus may there be æther-aerial and aer-aquatic creatures of indefinite minuteness and simplicity of structure.

But may not an animal live in a single medium, as for instance in air? Yes, if its mass be large enough, so that it may be placed around the leaf, thus giving to nature a cell or stomach, with food only for contents, the medium for respiration being outside. Now a verification of these deductions is precisely what we find in nature. The mixed medium of water containing air, is everywhere teeming with most minute and simple highly animated organisms, in which no trace of mouth leading to a permanent stomach can be discovered. They both breathe and feed by their periphery in whole or in part. But of all purely dry air-breathing species is not a stomach a characteristic?

And, indeed, of any animal considered as a subject of alimentation and exhaustion, may we not say that in the most general point of view, it is a large polymorphous cell, with outer and inner walls, and adventitious matter lying within? Drawing energy from the ambient medium in which it exists, it lives and gives out to that medium aeriform particles which tend to concrete into the beautiful forms of vegetable nature. These particles again, when concreted, the same animal lays hold of and places within itself again, destroying their concretion both mechanically and chemically, and presenting them within itself to its own working organisation to be assimilated by it to itself wherever repair is wanted,—and all this for supplying the desires and demands of sensibility, the well-being of which is enjoyment—of which, however, we cannot now speak.

These things considered, it must be admitted that there is no rational ground for indulging, after being enlightened by science, in that moral recoil which the sensitive soul naturally feels at first, when contemplating the animal kingdom, and observing, as is inevitable, that so many species are maintained in life, only by putting to death so many individuals of other species. If, indeed, this economy of food were carried so far that the amount of sentient life in our planet, the number of creatures which exist and could enjoy existence were diminished by it, there would be a legitimate ground of complaint. But all the evidence goes against such a conclusion. Of those creatures which constitute the food of others, the world is as teeming as teeming can be. They have been endowed with such abundant fertility and reproductiveness, that if we are to seek out the causes of their sufferings, we shall find it in this fact, and their struggle for existence among themselves in

consequence, rather than in their liability to be made the prey of other species. Meantime it is worthy of remark, that the vegetable kingdom has been laid under the same law ; so that there may be as much vegetable matter as possible for vegetable feeders. Nay, all the excretions of animals when alive, and all their remains when dead, are appointed to be converted, if not immediately into animals, then into the beautiful and nutritive forms of vegetable matter. Add to this, that the species which crowns the zoological scale, and is called upon to a certain extent to preside over nature, has the power of adding immensely by cultivation to the fertility and productiveness of the soil, and therefore to the production of food for animals; and it must be granted that, so far as we can see, all that is possible in the circumstances has been done for the well-being and the abounding of animals.

Creation in its rise preludes as its offspring nothing but animated creatures, consisting of pure and undifferentiated protoplasm. But if they are to live, they must breathe, and they cannot breathe without becoming emaciated and requiring food to maintain them in well-being. Meantime there is no choice of food. The stronger must feed upon the weaker; that is, the stronger must cause the weaker to merge into them, and to be completely assimilated to them. Now, this being the primal nature of alimentation, it also appears that though such is the only food animals can have as yet, it is also the very best food possible, for the entire mass of that which is eaten is available for assimilation. There need be no rejectamenta at all. The economy is perfect.

Why, then, is an economy which seems so faultless objected to? The reason is, that the thought or spectacle of one sentient creature destroying another, even though it be under the necessity of avoiding starvation, hurts our sensibility. True, we do this ourselves every day without blaming ourselves. But that it should be an institution in nature, and that, so extensive as it plainly is, seems surprising and even shocking and disturbing to true devotion. The fact is, that in sympathy with the animal seized by another as its prey, we invest it with those feelings of anguish and misery, heightened by the horror of approaching annihilation, which we ourselves should experience were we ourselves in its place. But to all of this doubtless the unreflecting creature which is destined to become the food of the other is an entire stranger. There is also, I think, ground for inferring that a certain amount of compression, and that not difficult to effect, induces anæsthesia, so that to all that happens after the act of seizure the animal seized usually is a stranger. Besides, there is a state of wrapt attention, of which the lower animals seem to be eminently capable, during which, whatever injury may be inflicted upon the organism, no pain is felt. Of this a shocking instance was recorded in the public prints the other

day. A man (or rather a brute) took a bet, that his terrier, which had just killed so many rats in so many minutes, would kill as many more in the same time, though one of its legs was chopped off. The bet was taken. The terrier's leg was chopped off, and his owner won'the bet! Insects also, and even frogs, how little they seem to mind the most serious and even fatal lesions!

Let it not be asked why there should be, in sentient creatures, a liability to pain at all. Perhaps a liability to pain is implied in a capacity for enjoyment. And, at any rate, a liability to pain, when viewed as an institution in nature, is manifestly a benevolent one. It is the embodiment in the very organism itself of an argument to protect the integrity of the organism, far more influential, and far more extensively applicable, than any purely logical or intellectual consideration could be. That it should still exist and force the attention inexorably, and retain its hold of the sensibility, and, in a word, be pain, when the organism is fatally injured, and when the pain can of course be of no use as a protection to life, is merely one of those illustrations which are constantly occurring in nature (and which must be constantly occurring in every purely dynamical system) of the fact that the law must take its course. The design of the law is benevolent; and its fulfilment upon the whole is productive of happiness or protective against evil, but in particular cases it acts otherwise.

But, finally, it may be asked, why death at all? And here a most interesting inquiry presents itself in its relation with our philosophy. Nor ought it surely to be against that philosophy, that the conclusions to which it leads are eminently orthodox. Thus, the dissolution of a living organism considered as death, that is, as an evil which has befallen it, accompanied usually by pain, and certainly with the cessation of all previous enjoyments, and the possibility of all future enjoyments in the organism itself as the abode of sensibility—this, which is what is usually meant by death, does not attach to an organism, if its organisation be internally as perfect as it may normally be, and if it be placed in a perfectly harmonious relation with its environments,—provided that organism has been created in perfection at once. If Adam and Eve were called up into being of full size upon the spot, and that spot a paradise, then, for aught that appears, they would be naturally immortal. Anatomy, when it separates itself from pathology, and as a purely mechanical science, makes a study of a full grown healthy human body, can discover no cause why the organism should strike work or fall to pieces after seventy or after seven hundred years, or at any time. Our organism is not like the time-piece of the watchmaker, which from first to last consists of the same particles, which therefore eventually cannot but be exhausted, and so becomes a wreck. Organisation, as fast

as any particles in an organism are worn out by work, replaces them with others, fresh from the sunbeam. And—but for a certain fact—the human frame, if fitly placed, would be a living structure as truly everduring as a river, which, by the aid of its surroundings, the mountain, the ocean, the sunbeam, runs on for ever. What that immortality-destroying fact is, in a religious point of view, we have nothing to do with here. But it belongs to us, as explaining phenomena scientifically, to state what it is that prevents immortality now. And that we find in the appointment for the first woman, that she should bring forth children. Under the cosmical law of assimilation (acting as reversion, one of its most inexorable forms), whatever has had a first childhood, must have a second childhood too. Birth and growth imply decay and death. But meanwhile by birth, and during growth, as I have elsewhere shown in detail,* the human organism has become the mother and nurse of a non-material, a purer than ætherial being, in a word, a spirit, which survives the dissolution of the organism as naturally as the material atoms themselves, of which that organism consists.

But while it thus comes out scientifically, that the immediate creation of the first man, as affirmed in Genesis, and his immortality harmonise and imply each other, we ought, if we are to apply the term death, viewing it as an evil, to the whole of creation, to limit our conceptions to the actual amount of the evil that is in it. The fact is, that with regard to the whole of animated nature, with the exception of our own species, death, inasmuch as it is the necessary preliminary to dissolution, is not an evil; for the dead need no food; and every living creature before it dies tends to give birth to more; and that state of matter which is secured by dissolution is a higher state of physical existence than that in which the same matter forms an organism. When in a state of dissolution, the constituents of living bodies are æriform, and this is a more perfect state than the concrete, or indeed any other state whatever. And hence the determination of organisms towards death and dissolution, as soon as the ancestral development insisted upon by the law of assimilation has been attained, is not an evil. If the organic elements had feeling, and were capable of desire, they might possibly wish, and ought certainly to be excused for wishing, to be off from the often questionable situations in which they are held down in an organism. Better surely a dance in the sunbeam—a dance, moreover, during which they may be constructed, according to our philosophy, into certain tissue-elements, which, in their turn, need only to be combined, in order to give being to living organisms aloft, so that the dissolution of heavy life on the earth's surface may possibly animate the air with most light and lucid creatures.

* See Part I. p. 151.

CHAPTER XI.

OF REPRODUCTION AND SEX.

It has already appeared to a certain extent, and it will be shown more fully in another chapter, that a single material element may be accepted as a prefiguration of an entire individualised organism, animal or plant. And here, after considering the functions of respiration and alimentation, we may inquire whether a single material element does not prefigure also the function of reproduction, and haply explain also the fact in nature of difference of sex.

The function of reproduction is generally regarded as the very characteristic of living nature, whether animal or plant. Many individual objects are supposed to want it, and to them is denied a place in either kingdom. But here, as so often, it falls to us to extend the limits of conception. Reproduction is not confined to what is usually regarded as an organic being, whether animal or vegetable. Reproduction, as a *nisus* at least, is universal. It is, in fact, the simple expression of the law of assimilation operating in time as well as in space. Thus wherever there has been individuation by integration of successive parts or particles, then, though the process may have been completed inasmuch as it has reintegrated the ancestral form, still that process must tend to go on; for never and nowhere is there any suspension of the cosmical law. It cannot now, however, bestow its operation on the further construction of that which has already attained to its fully developed form and structure. It must now, therefore, operate otherwise. And therefore it is only to be expected that it will commence the construction of other forms which shall be like the ancestral form in its first beginnings, and which shall be capable of development into that form when the conditions of existence are suitable and aliment is supplied.

Nay, the reproduction of like objects by antecedent objects must go much further than this. And so it manifestly does. Thus let there be a saturated fluid, liquid or æriform, and into it let a bit of concrete

matter project or be suspended, and then as soon as the temperature falls or any condition favourable to solidification occurs, something concrete, an element of crystal or of sublimate will soon form and grow into visibility, and in due time come to possess the features proper to its kind. Again, when a vessel with smooth walls contains that which is wholly liquid—as, for instance, pure water—that liquid may be cooled far below the degree at which it usually concretes. But on dropping in a particle of a concrete, say a bit of ice, into the water, the whole immediately assimilates itself to it—the whole starts into ice. And conversely, when such concretes are overpowered by a fresh affusion of liquid, the latter assimilates them to itself; the concretes disappear in it, and the liquid is reproduced. And these phenomena, which may be observed from hour to hour in the laboratory, take place secularly in nature. Thus adjacent rocks, even where entirely different origins are assigned to them, assimilate or tend to reproduce each other on their confines, and are seen to “pass into each other.”

But it is in reference to more fully individualised and more easily transformable objects that the phenomenon of reproduction, either molecular or massive, shows itself more articulately. Such is the process of healing and of ulceration. Thus, given a living concrete tissue and liquid plastic matter adjacent to it, then either the solid or the liquid, according to the intimate conditions of existence, proceeds to reproduce the other. If the concrete prevail, there is healing up. If the liquid prevail, there is ulceration or destruction of tissue. Of the same order are the phenomena of normal growth generally. Given a group of living cells and a suitable pabulum, then these cells, nothing preventing, will generate others. Nay, so general is this phenomenon, that it is most usually held to be imperative, in order to the development of more living cells, that there must be pre-existing living cells to begin with. Let us not fail to remark, however, that in order to the increase of cells an external pabulum as material is not indispensable. The law of assimilation may also, and that most economically, be fulfilled by the segmentation or spontaneous fission of the parent structure. And this, being the most economic mode of all, we see to prevail in the beginnings of very many species, from the most simple *Gregarina* to the human ovum, the commencement of the most highly organised being.

As to the morphological principle in the developing individual which rules the phenomena, and which along with assimilation to the parental form determines the actual form and structure of the young individual, it is the same law (of assimilation) in its cosmical function, namely, a determination towards the spherical and cellular. And this is the usual course. Under the linearly-acting-forces or currents arising from a situation on the surface of a revolving gravitating sphere, the form of the

future individual, spore or ovum, which at first is to be expected (as has been shown) to be more or less spherical, becomes elongated. But assimilation, at once to the previous sphericity and to the spherical in general now reappearing, forthwith tends to partition this elongated form into two shorter or more nearly spherical parts. Then these, by the same process, are partitioned into two others, and so on; the increase thus taking place at the rate of 2, 4, 8, 16, 32, &c.; the portions or cells obtained by this process of segmentation resuming more and more the spherical form.

And here we may remark in passing, that in this way also this phenomenon is to be explained that every axial form, filament, or fibre tends to be crossed by nodes or septa and to become moniliform more or less (muscular fibre, conferva, axis of plant, &c.). These nodes or septa, &c., are a misus at giving equators to the axial forms (branches and foliage being the more successful fulfilment) and of breaking down linear forms into frusta, which shall be as spherical or monometric as the conditions of existence will allow.

But a reproduction still more elemental than any of these attaches to our theory. Thus the nucleus of our material element consists of 32 ætherial elements confluent into one, but previously discrete. Hence, under the law of assimilation, a twofold reproduction. First, by secular partitionment and assimilation one material element will tend to reproduce its former state, and to part into 32 ætherial elements again; and, secondly, out of these 32 ætherial elements there will tend to be produced 32 material elements as from the spawn of one. For each of the 32, after being set free, must, under the law of assimilation, be possessed of a virtue which it had not before. It must continue to mirror within itself, and, as it were, dynamically remember and so to act towards the reconstruction of such an object as that of which it is itself the offspring. It must, in short, act as a spore, a bud, or an ovum. A single material element having opened up must tend to give birth subsequently to 32. And thus we find at the very origin of material nature, the prelude of that very great fecundity of organic species which has excited so much wonder, and which, in consequence of the necessity of alimentation with an inadequate supply of food, gives rise to the struggle for existence, which is the cause at once of so much suffering and of such advancement in nature. For in this struggle those individuals who are least fitted for it, and which occupy the worst positions, must succumb; while the survivors, impressing, as under the law of assimilation they must tend to do, their superior points and powers upon their descendents, must tend to be the parents of an improved progeny. If it be asked, how come they to be possessed of those superior points and powers in virtue of which they have survived, the

only answer possible as yet is, that in them, along with the vigorous operation of the special type as maintained by heredity (that is, the operation of the law of assimilation in reference to time), the influence of the pangeneric type, the type of types, the tendency towards the spherical and cellular (that is, the operation of the law of assimilation in reference to space), must have been eminently strong, as also their situation among their environments, compared with that of others of their own kind, most favourable. And it is curious to remark, that this view, though so different in its conception and statement, does not differ practically from that of Mr Darwin. For the capacity or tendency to indefinite variation in all directions which he proposes, may also be described as a general tendency in organisms to radiate from their centres, which is the same thing as a *nisus* at the spherical and cellular.

But in order to account for the actual forms of all organic species, other morphological data than those recognised in Darwinian writings are indispensable; and it is to be regretted that that which is capable of explaining only a part should be advanced as if it could explain the whole. In order to this, along with a knowledge of the law of assimilation operating both in reference to time and space, and thus, while maintaining and reproducing hereditary types, advancing them also towards more perfect structures, a knowledge is also indispensable of the forms of the atoms of the organic elements, especially carbon, and of certain vapours, especially common vapour and ammonia, and of many planetary conditions and applications of forces at present wholly unknown, and which are likely to remain wholly unknown so long as students of physical science refuse as they do now the helping hand of theology. Nay, after these things have come to be known, it will probably be ages before the human mind can give the plan or explain the structure of the simplest and most minute of the Protozoa. The human eye, when assisted by the most powerful microscope that ever can be constructed, and by means of it seemingly made to touch the object of study, is yet at an all but infinite distance from the region where individual molecules come into view. For them there is the mind's eye alone. And in this there are at the present day not only so many motes, but so many beams, that in order to clear rational vision a distant future must be waited for.

Meantime, referring to Darwin's theory, the idea should surely exalt our conception of the Creator, that already, from the first, in the structure of the material element itself, He, having eternity at his disposal, provided, that in good time the human hand should be given to nature, and in the same species a brain so powerful and so related to the spherical, the type of form, that in its focus of action as an organism of aether with its appropriate currents and matter supporting it and

them, a being of a higher order than the merely material or the purely ætherial should receive its birth and grow in energy, even a spirit, which, when the organism that served as its mother and nurse has performed the cycle of its function, and given up its matter in individual particles to fly about in the air for a season, shall continue to exist, and go to join the world of spirits, and live in the realm of light, and participate in an endless progress towards perfection and in enjoyments of the highest order.

A theory of development, whether it be the Darwinian or any other, does not deny design in nature. Rather it claims all nature as one grand design, yea, a design realised with the utmost perfection and economy, inasmuch as it assigns to those parts of nature which are first created the duty of realising the design of the following parts without needing the collateral interference of Him who is the author of all—an interference which, if it were needed, would it not imply some defect either of foresight or of power? No doubt, during the working out of such a method of creation, it is only to be expected that many individual objects shall be built up in which all the attributes of the mind of Him who designed the parts as a whole shall not appear, at least to such finite insight and thought as man possesses. The awarding existence to a dynamical system which is to act mechanically, and therefore elastically and rhythmically, and to be allowed to effloresce into all that belongs to it as such, implies that, along with the development of opposite polarities, there shall be also that of opposite endowments. And, therefore, we may expect in sentient nature also, objects and actions which, viewing them in the light of sentiment, we must regard as permitted rather than as directly willed by the Creator. Now this is precisely what we find in nature. The grand method adopted, while it gives to nature an all but infinite variety of objects, and never fails to build them in harmony with themselves and their surroundings, so that the machinery is everywhere exquisite, and the actions everywhere appropriate to the machinery, yet gives room for a sentiment which both the object and the action most immediately awake that not unfrequently conflicts with those attributes in the Creator which our intuitive convictions of what He is, as also the moral nature which he has awarded to us, peremptorily insist upon.

It is strange how little regard theologians sometimes pay to features in creation, which to some naturalists seem insuperable difficulties to the belief, that nature is the creation of a benevolent Being. A writer who is at once an officiating clergyman in Cambridge, and a professor in the University (nay, a master in mathematical and physical science, and the author of a molecular theory which is very scientifically wrought out), in a work on the Scripture doctrine of creation, when criticising the

theory of evolution and repudiating it, again and again adduces the lion as a witness, that such a noble creature could not have been created in such a way! Surely the lion is *par excellence* one of those destroyers, in reference to which every considerate theist should be thankful for any derivative theory that would account for their creation otherwise than by the very finger of God directly applied to model a brain, teeth, claws, tendons, and skeleton, all so exquisitely co-ordinated with one idea, and that fitness for the one special work of seizing and destroying living creatures as good or better than the beast itself, only not so strong.

But to feel the necessity in order to the satisfaction of our moral nature of some large and all-embracing view of creation, we need not wander from our present subject. When thinking of reproduction, the fact of difference of sex presents itself. Now that this difference is not essential to life, and that it exists in material organisms alone, we are assured. And looking at it without the aid of adequate science, really nothing seems more uncalled for. Why, may it not be asked, is one-half, perhaps, of all the individuals, and that in the higher and highest species, rendered useless for the continuance of the species without the concurrence of the other half, this other half being otherwise useless altogether for this great end? What, may it not be asked, can be the reason of the institution of sex, and how can it have come into being, sex, a peculiarity of organisation extending to almost all organic beings, and which, in our own species, is the cause of so much suffering, and if of enjoyment also, yet of enjoyment so low, that all are ashamed to speak of it? It certainly looks as if to account for such a state of things, we must suppose that nature is the work of some Demiurge, or, at any rate, that there must be some or other cause than that of a Supreme Reason acting freely in the absence of all limitations.

Now, does not a reference to the structure of the material element itself, as it has been conceived in these pages, hold out a prospect of explaining this seeming imperfection in the individual? Thus we have supposed that the body of the material element consists of 32 ætherial elements confluent into one, yet bearing traces of genesis in two layers of 12 and 20 respectively. Moreover, on conceiving the genesis of that element, we supposed that the 12 were central and the 20 peripheral. Now that we did, simply because this arrangement was the easiest mode of synthesis. But morphologically considered, the structure would be more perfect, more spherical and cellular, if the 20 were central and the 12 peripheral. And for anything that appears to the contrary, this arrangement may exist as well as the other. Now, if so, if both may be, then both will tend to exist in equal numbers; for as soon as one of one kind has been constructed, the law of differentiation (induction) will tend to secure the construction

of one of the other kind as its neighbour. Here, then, is at once an encouragement to inquire whether this difference at the very root of material nature may not prelude and necessitate a difference of sex in composite organisms; for nothing is more remarkable, where sex is most fully pronounced, than the equality of the numbers of both sexes.

But of more consequence to the investigation it is, to inquire whether the difference between the two kinds of material element has any analogy to that between the two sexes in the same species. Now, as to this, it may be remarked, that though the law of assimilation will doubtless impose the same ætherial volume overhead upon both, yet the body (or nucleus) of that in which 20 are central, will tend to be somewhat larger than those in which 12 are central. In this, then, we see an accordance with another phenomenon of sex, for one of the sexes in the same species is generally somewhat larger than the other.

Further, when compared with everything else, the two sets of material elements may be said to be similar to each other. But when compared with each other, they may be said to be dissimilar as well as similar. Now hence, in virtue of their dissimilarity, they will tend to unite together; and in virtue of their similarity, they will tend to remain separate like similars in general. And these twofold tendencies will be satisfied if, as a consequence of the act of union, the amount of difference between them be diminished; for in that case, after union they will separate, and thus will remain separate until the previous amount of difference accumulate again. As to the mode of action in both, arising from difference between them, it must tell outwardly by a difference in the times of the excursions and retreats of the ætherial elements in their atmospheres or dynamispheres. In the one, the excursion of 12 must be simultaneous with the retreat of 12 in the other, and that of 20 with 20, and consequently 12 must be ever encountering 20 in the same phase of excursion or withdrawal. Along with a perfect receptivity on both sides, there must therefore be also a certain conflict. And this conflict must, during the time of union, tend to confuse the reciprocal rhythm altogether, and indeed to render the same rhythm radiant in both, and so to bring the union to an end, and to effect separation; on the occurrence of which the previous normal action (preluding respiration) will gradually be re-established. It must be remarked, however, that the state of the two, after this sympathetic and yet conflicting state of union, will not be quite the same as it was before. Assimilation at least as to an aura must, to a certain extent, have taken place between them. A loss, at least as to its previous power of functioning, must have been sustained on the side of that whose parts most engaged are represented by the number 20, and a corresponding gain must have

been made on the side of that whose parts engaged are represented by the number 12. Supposing, then, that we now are in the midst of speculations which relate to sexual union and its consequences, it follows that of the two sorts of material elements which are otherwise identical, but differ as to the order of the supraposition of the two layers of ætherial elements which constitute their body, that in which 12 are central—that is, the kind most easily constructed—preludes the female sex, while that in which 20 are central preludes the male. Now is there not here again, one of those somewhat obscure verifications which, nevertheless, are all that we can reasonably expect, while yet we are at such a distance from the visible reality? Is it not generally agreed that the female in general is more easily constructed than the male, and that the as yet unimpregnated ovum or ovule is a simple thing compared with the spermatozoon or antherozoon?

Moreover, it is not without great interest to observe, also, that this theory of the genesis of sex, implies that originally every simply individualised organism tends to be bisexual or hermaphrodite, containing in its own organism both male and female parts; but yet bisexual on such conditions that, in order to the continuation of the species by a succession of individuals, reciprocal union and impregnation is required. Now, that such is the tendency of actual nature, embryology and natural history go to prove more and more every day, although discoveries in this line, seeming as they do to imply the superfluous and therefore the unexpected, are but slowly made.

And here a question with regard to cell life suggests itself. Are not the nucleus and the nucleolus in some respects in the relation to one another of the different sexes?

But enough, it will be said,—long ago enough—of such transcendental imaginary biology. And, indeed, I might not have ventured so far, if I had it not to remember how, when I was young, I was the object of ridicule at the University for accepting doctrines in “transcendental anatomy,” newly imported from the Continent, which are now the common belief of everybody. Besides, the enjoyment that attaches to what promises to be new insight into the mysteries of nature, is so great and so high, that he who has experienced this kind of enjoyment in any good measure is emancipated equally from the love of applause and the fear of ridicule. The social principle in our nature is, no doubt, sometimes very inexorable. Man is emphatically made for loving and being loved, and therefore honoured by others of his own kind. But where these conditions of social enjoyment are denied, he may have a grand revenge, by devoting himself wholly to the pursuit of truth.



CHAPTER XII.

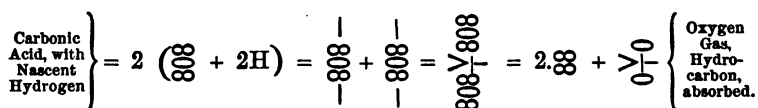
VEGETABLE MORPHOLOGY—ITS GENERAL PRINCIPLES.

WITH the light which we now possess as to the possible origin of difference of sex in organisms, we are in a condition to venture on an explanation of the forms and structures of plants and animals in some of their more minute details. And here it will be remarked, that our theory would lead us to treat first of animals and not of plants, as also of such as are most minute and microscopic, rather than of those which are palpable and large. But it is so difficult to be sure about that which is invisible except by the aid of the microscope, and the animal cell is so rapidly changeful, that scientific prudence dictates our taking in hand first, not the animal cell in the animal, but that cell, when rendered more stable by being encrusted or encased in cellulose, that is, the vegetable cell; not indeed when single or as a microscopic object, but when aggregated and constituting a plant of the more perfect or typical kind, say a flowering plant.

Now here we may remark, in the first place, that in order to be able to analyse and come to understand the form and structure of the typical plant, and of the vegetable kingdom generally, its relation to the animal kingdom must be remembered. That relation, in its most eminent feature, is to supply the latter with food. For although the animal may have a form which exposes as small a surface as possible to the ambient medium—that is, may be as compact and spherical as is compatible with a locomotive apparatus, &c.—yet inasmuch as an animal is essentially a breathing creature, it cannot but be continually losing of its substance, and imparting that loss to the ambient medium. And hence the place in nature for the plant. It is wanted to gather up the products of respiration which are diffused in the atmosphere, and to present what in them has been lost by the animal for the reintegration of the organism again of the latter. The plant, therefore, may be expected to have a form which is expanded as far and wide in the ambient air as that of the animal is centralised. Now this is clearly

the character which the vegetable kingdom displays. Its characteristic is organism expanded into thin laminæ named leaves—laminæ which possess the power universally, during the period of day and sunlight, of absorbing the products of respiration and of decomposing the carbonic acid, appropriating its carbon and letting the oxygen gas go free; thus providing for the animal kingdom aliment both ways: (1.) Aliment for redintegrating the animal tissues; and (2.) Aliment for sustaining respiration!

What the apparatus in the leaf, by which this decomposition of carbonic acid is effected, the popular chemistry has as yet made no step towards discovery. It is only known that in the laboratory such decomposition is impossible by any process which could be supposed to take place in organic nature. I have elsewhere shown that it arises, in all probability, from the construction in the vegetable tissue of tetratoma of hydrogen, which, being highly negative in form, are similar to oxygen in their mode of action, and are therefore repulsive of the oxygen which exists in carbonic acid, and so decompose it. The process may be imagined to be something of this sort. In the sunny leaf, where essential oils, &c., are being developed, let there be atoms of nascent hydrogen. And let one atom attach itself to each pole of the atom of dioxide of carbon as if to reduce all to common vapour and glance-coal at once, then instead of this, and for its indefinite postponement, we may have the equations—



Possibly in some such way may carbonic acid be decomposed by the power of the living foliage when aided by the incidence of the sunbeam or the light of day. But meantime we must content ourselves simply with regarding this admirable power as residing in chlorophyll, a substance in vegetable nature which is so named because to it the general verdure of the vegetable kingdom is owing.

The expanded lamina or leaf, then, is the characteristic element of vegetable nature. But in being led to this conclusion, have we to give up the spherical superficies which we have maintained, that the law of assimilation gives as the culminative form of every object which is individualised by nature—a form seldom fully constructed indeed, but always aimed at? No; the vegetable lamina or leaf, or rather the umbrella of leaves which is the fully developed form of the leaf-bud (that bud as spherical as its mode of nutrition, &c., will allow), is also as spherical as these same conditions will allow. And if each single leaf in the phyllotaxy of the bud-system, while extending in a radiant

manner to the utmost acquires an elliptical, oblong, or very lengthened form, as it so often does, still the tendency to be circular shows itself. It generally subdivides the leaf into leaflets or parts, each of which, though developed under the assimilative influence of the whole leaf, is more circular than the whole.

And while the circular, as modified by its unavoidable mode of nutrition and pressure in the bud, appears in the individual leaf, and still more in the system of leaves, which is the development of the bud, the spherical appears in the distribution of the whole system of leaves proper to the entire tree, shrub, or plant, if it be fully borne up in the atmosphere by trunk or stem; the hemispherical, if it be not. On this subject I saw my way (as it seems to me) so long ago that on July 12, 1860, I read a paper before the Botanical Society of Edinburgh, entitled "Vegetable Morphology, its General Principles," which was, I believe, published in the Transactions of that Society, and also in the *Edinburgh New Philosophical Journal* for October of that year, in which the view I am now advocating was set forth. An extract from that paper will serve my purpose now, while no one need regret the repetition, since the periodicals in which it has already appeared have, I presume, gone into the vault of all the Capulets:—

"The forms of plants in general, the plant-form, why is it what we find it to be, and not otherwise?—that is a question which science has not yet answered. Philosophical botanists have indeed shown that all the more perfect plants may be regarded as consisting of an axis with its appendages; and that all these appendages, however varied in their forms and functions, are either leaves or transformations of leaves. They have also shown that all the special organs of plants have their uses, uses often manifold, and always good, and that the whole vegetable kingdom is beautiful, and calls upon every beholder that possesses sensibility to adore the Creator. But it has not yet been shown why the forms and organs of plants are what they are, and not otherwise; why the typical plant consists of an axis tending to spread out and radiate upwards and downwards into branches and root, the former tipped by the foliage and fruit, the latter by the rootlets and spongioles; why plants consist of the matter of which they do consist, and not other matter; and why they are so highly coloured and so fragrant. For all these features of the vegetable kingdom, and others of the same order, it has hitherto been possible to assign, not physical and physiological, but theological and moral reasons only. It has been possible to refer them only to the will of the Creator that they should be as we find them. Now, this is no doubt the ultimate reason; and for moral purposes, and for men in general, it ought to be sufficient. But to the man of science it is simply equivalent to saying, 'God

knows;' for the man of science is not at liberty to forget that whilst the Creator is the absolute Will, He is also the Supreme Reason, and as such has implanted in the soul of man the instinct of Philosophy, whose calling is to lay hold of Nature and wrestle with her for light as to the reasons of things, and whose word to Nature ever is, "I will not let thee go except thou bless me.'

"Doubtless there is a sufficient reason why the plant-form is as it is and not otherwise; and it is for the philosophical botanist to discover if he can what that reason is. To this inquiry there is in fact a moral and a theological, as well as a purely intellectual stimulus. Thus the forms of plants, at first sight at least, seem to exist in violation of all wisdom; they seem to be the very counterpart of those forms which pure intelligence, contemplating excellence of form as such, points to as the best—the very counterpart of those which geometry and dynamics sanction. Thus, though they be so useful and so beautiful, they are of all things the most fragile and fading; they are the sport of every blast. Other beautiful products of nature, gems, for instance, or pearls, may be set in gold, and stored up or worn by many wearers without being worn out. They preserve all their charms for many generations. But the most beautiful flower, the most fragrant nosegay, is faded before the evening be over. Now, why is this? Constant observation of the fact may indeed have so familiarised us with it that we may never think of inquiring, or even deem it needless or strange to ask. But there can be no doubt that if, in perfect ignorance on our part of the fate of flowers, a lily or a rose were presented to us, we could not in the first instance feel grateful enough to him who had given us such an exquisite production of highest art, yet, as soon as we saw how it was going with it, our gratitude would soon give place to a still stronger indignation, that he had merely mocked us with the possession of a thing so fading as to seem worse than the want of it. Now, why is it so? Why is the plant-form so fleeting? I answer, because it could not be more solid or more lasting than it is, if the vegetable kingdom is to take its place in nature, and to fulfil its mission there—that is, to intercede between and unite in harmony the fickle fleeting air and the fixed earth. Plants do not exist in disregard of the laws of a pure morphology—that abstract doctrine of form and structure which geometry and mechanics teach, and which the forms of the heavenly bodies, and of all stable structures exemplify. Plants realise those very forms which are most stable and cosmical up to the full measure that is compatible with their place and calling in nature, and the end they are appointed to serve.

"But here it may perhaps be thought that all this is no more than an affectation of mystery, a raising of difficulties where none exist. That

the forms of plants should be fragile, it may be justly said, so far from being a fault in their construction, is the very circumstance on which their usefulness depends; for, to the very extent that they are easily destructible, they are suitable as food for animals, a class of beings higher in the scale than plants, beings possessed of sensibility, beings such that a state of physical well-being in them is a state of enjoyment to them, and so teeming in multitude, and so worthy of existence, that for their sakes it may be said, in a high sense, that next to the glory of the Creator, creation exists, yet beings such that they are all in want of food, which ultimately the vegetable kingdom alone can supply, and which it does supply well in the very degree that it is fragile and easily destroyed.

“ Now, against all this I have nothing to advance. I desire rather to appreciate it to the full. But I maintain that we have not reached all the reasons, or even the primary reason, why an object is as it is in all its details, and not otherwise, when we have discovered its economic use whether to ourselves or to other animated beings which are denizens of the world along with us. Such interpretations are good so far as they go; but the vastness of nature, and the multitude of its relations, demand a larger view. Thus, as to the point in hand, if we regard the vegetable kingdom as fashioned solely so as to form the best food for animals, we are thrown aback and silenced as soon as we are called upon to turn round and mark the abundance of uneatable and poisonous plants in nature. We are obliged to confess that our explanation is good only so far, but not adequate to account for the whole. The truth is, that we must keep constantly in mind that creation is a manifestation of other attributes of God as well as His goodness, and specially of His unity and immutability—in one word, His perfection. Hence in nature a prevailing unity of structure, and an universal harmony or homology of form; and hence, on the part of the student of nature, the indispensable necessity of a doctrine of general homology, as well as of special utility. With regard to the forms of the vegetable kingdom, for instance, besides their relation to animals as food, they exist in many other relations. . . . The wonderful, the beautiful fact is, the number of ends, each great in its own sphere, which are obtained, nay, as it were, spontaneously fall out through the fulfilment of a single law, when the position of that law is supreme. It is the same in the moral world; but that by the way.

“ What I desire now to affirm is, that in reference to the vegetable kingdom, as in reference to every realm in nature, there is a supreme law; and that in so far as it is purely determinative of form, it is purely morphological, purely mathematical and dynamical. The proprieties of form and structure, viewed in the light of pure intelligence contemplat-

ing a system, an unity, expanded or to be expanded in space and time, are never, either here or elsewhere, violated for the convenience of the individual. Universal order is never sacrificed to private advantage. Euclid of old, when he was inquiring into the first lines and properties of form, and composing his immortal work in the light of abstract intelligence, and so that it should culminate and close in the discussion of the five regular polyhedrons, was paving the way, the only way, for the right understanding of nature. And, alas! after more than two decades of centuries, we have now to take up the subject very much where Euclid left it.

"The supreme law to which I now refer is this, that every individualised form in nature shall tend towards that which intelligence gives as the most perfect of forms, and shall attain to that form so far as is compatible with the nature and environments of the form-possessing object, as being also something else and something more than merely a form.

"But what is that form which intelligence declares to be the most perfect as form, and in which I maintain that the first lines, the most general features of a truly scientific morphology are to be sought and found? To this I answer, that were it not that demonstration is needless, because it has been demonstrated so often before, it might be demonstrated here, that that form is the sphere.

"But it is here to be remarked, that of spheres considered as realised in matter, two kinds are possible. There is *first* the solid sphere, or sphere commonly so called; and there is *secondly* the hollow sphere, or spherical superficies, or sphere properly so called.

"Now I maintain that these two are the forms which it is the primary office of the physical forces to develop, so far as circumstances do not forbid their development. The proof of this I cannot enter upon here in detail; but this may be here remarked with regard to these forces, that however manifold their names, they are all of the nature of attraction or repulsion. Now attraction, as has been demonstrated since the days of Newton, and might have been inferred from the first morning that a dewdrop was observed, has for its first function to fashion all individualised portions of matter into solid spheres. Repulsion, again, has no less obviously for its first function to expand these solid into hollow spheres; so that between the two they constitute a complete apparatus for the development of these most perfect, most generalised forms, and for rendering them the forms of universal culmination. Nor is this all: if attraction and repulsion be not co-ordinate in extent and force,—if attraction be appointed to rule on the great scale and at first, and repulsion on the small scale and at last—then these two forces not only give a contour to natural objects, they give also a course to

nature. They prescribe as a rule, that an object shall be first constructed as a solid sphere ; and that then, after being as such the representative of the prevalence of attraction, its particles shall tend to expand, and its form to develop, so as to distribute themselves in a spherical superficies, the object thus becoming the representative of the prevalence of repulsive power, or heat.

“ Now, in these facts and inferences an account of the first lines of vegetable form and life is to be found.

“ In keeping with what has been said of the solid sphere (that it is the fittest shape for a deposit or store of such matter as it consists of), it is seen to be the choice of Nature for the form of the vegetable being when deposited anew in the soil, when on its travels from one locality to another, when housed in winter quarters, and, generally, when the aim of Nature is to store up as much living matter as possible, so that it shall displace least of the surrounding matter and expose itself least to external injury. So far as the mode of nutrition and the type of the species permit, and as often as there is unity in the organ, the solid sphere is the culminating form of fruits, seeds, spores,* tubers, buds, &c. Nor is this all the verification which our theory derives from the phenomena. In accordance with its doctrine (that the course of subsequent action consists in the expansion of the material constituting the solid sphere into a hollow sphere, so far as the conditions of existence permit), the germination and evolution, the growth of the plant is but the protrusion and development of the contents of such solid spheres or spherules as have been named, with assimilation of surrounding matter. That the reproductive forms of plants are more dense than their other living forms generally, is matter of common observation. Vegetable matter in general floats, but seeds sink, and in fact their value is usually estimated by their density. They have invariably contents which they tend to protrude.

“ Moreover, the limit of form towards which growth tends is nothing else but the hollow sphere. In consequence of the extreme difficulty of constructing this form, it is indeed, when not of microscopic minuteness, usually reached only piecemeal, only in morsels, only by the unfolding of small disks (leaves) supported on radii (axes, branches, petioles), to which the peltate leaf or system of leaves terminating the branchlet or petiole is normal, as the spherical surface always is to its radii. Many, indeed, are the obstructions to the development of a spherical contour, many the impediments in the way : as, for instance, the structure of the embryo, and the specific development proper to it ; the supply of food, not equally all around but in certain directions, and

* This would be the place for an allusion to the pollen also, were it not that this product of vegetable nature requires a separate consideration.

sometimes in one only ; the embarrassment of the individual plant-form in its relations with other plants, with the ground in which it grows, the weather, &c. Still, with all these limitations, it is remarkable to what an extent the spherical is actually attained in the contour of fully developed outstanding plants and trees, as also the hemispherical in those which grow in tufts or clumps. The primary axis which carries up the first foliage into the air, does indeed often keep the lead which it takes at first, thus giving as the geometrical form which circumscribes the tree, not the exact sphere, but a spheroid (the form which is nearest to the sphere), the longer axis perpendicular to the horizon. Let but the eye, when wandering freely over Nature where her forms have not been modified by the artistic but mutilating hand of man, only mark the general contour of plant and tree, and construct in imagination the geometrical form by which the plant form in the eye will be best circumscribed, you will wonder how often the circle in profile, the sphere in full form, is called for ; and if not just these forms exactly, then those which constitute the least departures from them,—the ellipse, the spheroid or ovoid, the semi-ellipse or flattered tuft or clump or cone.

“ This, the first law of vegetable morphology, or rather of morphology in general, as illustrated by the vegetable kingdom, enables us also to explain in a satisfactory manner a phenomenon observed in simple plants or plants with a single axis, which in itself has been considered as strange, and seeming even to interfere with specific identity of form. Thus it is generally to be remarked of simple plants, and the fact is always introduced into drawings of ideal types of plants, such as those which are figured in the popular works of Schleiden and Unger, that their lower and upper leaves, whether viewed in reference to their disks or their petioles, are very imperfectly developed compared with those about the middle axis. The upper and lowest, in fact, are often quite simple, and want petioles altogether, though those in the middle between them are finely divided and fully petiolated. Now, what is this production of leaf-stalk and foliage about the middle of the stem but a normal development of radial and peripheral matter, bent on reaching and covering as far as possible the equatorial region of the plant-sphere periphery, a region which, being at once the largest and farthest from the axis, is most difficult to reach and to fill up? The phenomenon is usually explained by a reference to the condition of the vital action of the plant at different seasons,—its feebleness towards the beginning and the end of life, when the first and the last leaves are protruded. And no doubt the life of the plant is always co-ordinated with the work which it has to do. But why is life feeble at first, or why are the lower leaves developed when life is feeble, and why the same with regard to the last leaves, when the plant is touching on its

full development? Why but because that life, that energy, has a certain design, a certain law to fulfil; whereof the hollow sphere is the most general and the most perfect expression among all possible forms. The very same thing is in fact observed among forest trees and perennial plants, to which this doctrine of feebleness at first and exhaustion at last does not apply.

“But in what has preceded, I have taken for granted the existence of radii as well as a spherical superficies, of an axis as well as the foliage appended to it, of stem, branches, and petioles as well as leaves—of a scaffolding, in short, for supporting foliage widely extended in space, though belonging to a single individual, and though aiming at the formation of a single spherical shell of verdure. Now these radii, stems, branches, petioles, the law of sphericity can scarcely be held competent to supply. Were there no other law but that of the sphere which was determinative of the forms of vegetable nature, plants would be all parenchymatous and laminar, all leaf, frond, or thallus; the plant-form either successful in attaining the spherical form (as plant matter may, when individuality contents itself with minuteness), as cell or vesicle (*Sphaeria*, *Sphaerococcus*, *Hydrogastrium*, &c.), or unsuccessful, as is always the case where the plant is large, the *nisus* merely being indicated by the turning up or down of the edge of the frond, or the formation of a disk-like thallus, which is the first form of so many species,—now becoming a cylinder or tubular body (that is, a hollow sphere whose axis is indefinite), now a lamina turning round upwards and cup-like (*Cenomyce*, *Nidulariaceæ*), or pitted with lacunæ (*Stictia*), or turning downwards, or waved, or crisped at the edge, or over all the frond, as in many Algæ, Fungi, and Lichens. Now all this argues the influence of the sphere, and its power of direct self-construction without the aid of radii. And indeed to a much greater extent than in reference to the entire plant, the doctrine of the sphere accounts for the forms of the most fully developed and perfected parts of the thallophytes generally—those parts, namely, in which individuality has established itself most fully, and in which, consequently, the reproductive spherules or spores are produced. There is scarcely any of these tribes of plants whose forms do not culminate in spherical, hemispherical, or circular balls, shields, disks, or sporocarps of some such form, displaying lineaments of the sphere or its elements.

“But it is equally certain that, from the simplest species up to the most perfect, the plant-form shows a disposition to ramify and to distribute itself as far and wide as possible in the medium in which it grows. In the very simplest organisms (*Confervaceæ*, *Hyphomyces*), ramification, radiation, is already carried very far. And although there has been a reluctance on the part of systematic botanists to recognise

any analogy between this filamentation of these simple plant-forms and the branching of more perfect plants, yet, morphologically viewed, they are obviously and certainly analogous. Nay, among these simple plants, too, not only have we ramifications, but the rami or filaments even generally succeed in expanding at their tips either into laminae exhibiting the forms of leaves (*Delesseria*) or into float-vesicles, which are hollow spheres or spheroids (*Sargassum*), or into multiple branchlets (*Polysiphonia*), or into spore-producing cells, as is general. On comparing the branching of a forest-tree between the eye and the horizon in a winter day, when the foliage does not intercept the sight, with that of a finely branched confervoid in water, in a glass vessel held up to the light, nothing can be more analogous than the two. They must be due to the same morphological law. Nay more, shocking as the assertion may at first sight appear, there is nothing for us but to affirm that the vital nodes in the stems of perfect plants, and the septa in the filaments of the simplest vegetations, are analogous, and do in point of fact owe their existence in both (as do also the analogous productions in veins, lymphatics, intestines, &c.) to the same morphological cause—and that the doctrine of the sphere, the tendency of every axis to become at once hollow and finite, so as to approximate the hollow sphere as nearly in form as it may, thus giving ends to itself and closing up in the line of the axis step by step as it lengthens, while as yet its length has exceeded as little as possible that of its diameter. But these things by the way at present. It is the very existence of an axis and branches, often long, tortuous, climbing, that we have now to explain; for this, which is nevertheless the characteristic feature of the vegetable kingdom, the law of sphericity does not explain. We might indeed affirm cogently in general, that the sphere gives its own radii, and therefore that the law which gives the foliage gives also the axis. But in actual nature the axis takes such a lead, ascends, spreads, creeps, at such a rate, that it is manifestly the illustration of some other law. Far from aiming at a minimum of space for the plant to grow in, the stem and branches seem to delight in extending and even often straggling farther and farther."

The reason of this the article from which the above is taken proceeds to state; but not so well as another article, published in July of the same year, in *The Journal of Agriculture*, Edinburgh, "On the Parts which the Atmosphere and the Soil respectively play in the Development of Vegetation and the true Theory of Agriculture." To that I have recourse for what follows, returning to the former only at the close:—

"Of all the objects which nature presents to us, the vegetable kingdom contains the greatest beauties; and, of all the arts, the cultivation

of plants is undoubtedly the most ancient, the most generally practised, and the most important. It is to plants, in fact, that we owe, either directly or indirectly, all the food by which our life is sustained from day to day; and the number of families which it is possible to introduce into our world depends altogether upon the extent to which plants may be grown upon its surface. An all-wise Providence has not, indeed, intrusted the existence of the human family to the practice of any one art. By fishing, hunting, and pasturing—by merely gathering the roots, the seeds, and the fruits which the earth spontaneously produces, a stock of men is preserved all independently of the art of cultivation. But the increase of this stock and the progress of civilisation—the numerical, the intellectual, the moral, and the religious cultivation of man—mainly depend upon the cultivation of plants.

“Yet so far behind is our knowledge in this respect, that even at the present day we are in the midst of a keen controversy as to the very first principles of agriculture. Thus, on the one hand, it is maintained that almost everything depends on the atmosphere and the mineral constituents of the soil, and consequently (since the air can scarcely be operated upon by the cultivator) that the grand secret of successful farming consists in keeping in the soil, in a state suitable for absorption by the growing crop, an adequate supply of the mineral constituents proper to that crop, as these may be discovered from its ashes. And this may be regarded as the new light, which is due chiefly to the genius of Liebig. But, on the other hand, it is also maintained that neither the air nor the ashes of plants need to be much considered by the agriculturist, but only proper tillage and the supplying of the soil with well-rotted manure, the belief being that it is upon decaying organic matter in the soil that the crop mainly feeds. And this is the view which has prescription in its favour, and is most popular with practical men.

“Now, though these theories do not conflict in practice so much as might at first sight be supposed from their statement, yet they do conflict; and a final settlement of their respective claims, if it be possible, would certainly be not a little acceptable at once to the man of science and the cultivator.

“I think that such a settlement is possible, and I proceed to attempt it.

“But, in order to do this, the reader must consent to a preliminary question—he must consent, in fact, to the inquiry, *What is the place of the vegetable kingdom in the economy of nature?* That such an enlarged view of plants is necessary when our aim is to understand them fully, and especially when we wish to ascertain the best food for them, and how to apply it to the greatest advantage, follows from the very

nature of the case; for food is always a part of surrounding nature, and a demand for food on the part of the plant is an appeal to surrounding nature; and that such an appeal may be successfully seconded by us, it is plain that nature, in her contact and dealings with the plant, should be well understood by us, and her aid invoked in accordance with her own laws and in her own language. Now, though much has been done, and beautiful discoveries have been made in eliciting the relation which exists between the vegetable and animal kingdoms,* yet the same success has not accompanied such inquiries as have been made into the relation between the vegetable kingdom and the inorganic world. It has been too much the custom of scientific botanists to look at plants as individual objects irrespective of their place in nature—nay, to pluck them up expressly for the purpose of study, and to preserve them at home between folds of paper. Now, from such a mode of procedure great progress has no doubt been made in the classifying and naming of plants, but scarcely any light at all has been thrown as yet on the general features of plants, such as the cause and meaning of their forms, of their inner structure, of their composition, of their colours, of their fragrance, and but little for certain on the true economy of their cultivation. . . .

“For the discovery of the *rationale* of the vegetable kingdom, the plant must be viewed *in situ* as a part of nature—as a development in the place where it grows by natural law of a living ember given by the Creator, and designated a seed. Nor let the reader recoil from such a point of view, as if he were going to be remitted to his studies, and required to acquaint himself with all the details of natural philosophy, chemistry, and physiology, before he can understand what a plant is, and how it is to be cultivated. No more is demanded than a general knowledge of the chemistry of the atmosphere, such as is now possessed by every inquiring person, and a comprehensive acquaintance with a single law.

“And what is this single, this all-sufficient law? Let us lose no time in setting it forth. By natural philosophers it has been most generally named *the law of continuity*, that law which forbids abrupt transitions from one thing to another, and secures their passing into each other on their mutual confines more or less. By physicists and chemists it has been seized in various manifestations, and has been named now the law of *diffusion*, now the law of *osmose*, now of *capillarity*, now of *catalysis*, now of *affinity*. By physiologists it has been emphatically recognised, and under the name of *the law of assimilation* it has been insisted upon in one of its most important operations. By philosophers generally it

* See *The Chemical and Physiological Balance of Organic Nature*. By MM. DUMAS and BOUSSINGAULT. An Essay. 12mo. Baillière: London, 1844.

has been referred to as a certain all-embracing harmony of things—a certain strongly but darkly conceived *law of harmony*. Each student of nature has observed it to rule in his own department, and thus has naturally named it in reference to that department; but in consequence of that unhappy isolation from each other in which the various branches of science at present exist, no one has observed that these variously-named laws are in reality but various manifestations of one and the same law; no one has unfolded it in all its comprehensiveness. But this is necessary to our understanding of the vegetable kingdom, its place in nature, and how to aggrandise it; and this, therefore, though very shortly, we must attempt here.

“This law is to the effect that every individualised object, once statically constructed, tends (first) to remain true to its own type, and to hand down and perpetuate that type in every successive moment of its existence as an individual or a species, the conservative action which tends to this end extending also as far as the agency of that individual or species extends, whence (secondly) each permanent object in nature, each molecule, crystal, plant, animal, must also tend to impress its own type upon all others that lie within the sphere of its influence, to assimilate them to itself; and thus (thirdly) each must tend to bring all into keeping or generic relationship, and therefore to promote an universal harmony. Whether objects in general, or more than a few, shall succeed in thus affecting each other either deeply, or in any such degree as may be marked by the senses of an individual observer in the course of his life, or of such history of the past as we now possess, is a question of detail. It is the tendency only at once to permanency of the specific type in the individual, and to the assimilation of all to each and of each to all, and to its actual environments and conditions of existence, that our law affirms and provides for. And that such a tendency does indeed operate universally all nature proclaims aloud, inasmuch as all nature is seen to be a harmonious whole. Every object, while tending to continue true to its present self, and to echo and repeat its past in its future, tends also to mirror itself in the kindred objects around it, or to vibrate in harmony with them. A bright body illuminates the dark, a hot body warms the cold bodies around it. A polarised body polarises such as are susceptible of this mode of existence. Molecules of an eminently undecomposable nature, when introduced among others which are tending to decomposition, arrest that process. Salt preserves meat. And molecules which are themselves undergoing decomposition, when introduced among unstable molecules, assist them in decomposing. Yeast causes fermentation. Conduction, radiation, polarity-induction, catalysis, antiseptics, ferments, &c. &c., are all so many manifestations of one and the same law, which in all tends to the same issue, viz., to assimilate

to individual objects, or to that which is fixed in them as primary data, all the others around, so far as they are assimilable or contain assimilable parts, and thus to secure a general sisterhood and harmony among all. I have lately shown* that inertia, elasticity, gravitation, polarity, and other agencies, may all be referred to this law, and are in reality merely uniform phenomena in matter resulting from its paramount operation.

"But for our present purpose it will be best to illustrate it in reference to *Assimilation*, as that process is manifested in the life both of plants and animals, and as it is understood in physiology. It is quite a typical illustration of our law, and as it is that by which all growth and life are maintained in organic beings, it is of supreme importance. Now, assimilation is simply to the effect that when two dissimilar yet kindred media meet together, the one consisting of plastic material, and the other of a living organism in want of redintegration or increment, that organism, while maintaining its own type, assimilates more or less the plastic material to itself and organises it; while the plastic material, on its part, assimilates more or less the organism to itself—a circumstance which, though not remarked in physiological works, is altogether needful to be kept in mind in order to a full and satisfactory conception of the phenomenon. Thus, if the plastic matter consist of cell-material in the liquid state, and the living organism be a single living cell, or a mass, or, as we may say, a battery of living cells, constituting an organism which has suffered lesion, or is not yet full grown, then the plastic liquid in contact with the cellular concrete becomes itself cellular and concrete; new cells are developed in it; the organism grows. But the assimilative power is not all on the side of the concrete part. In the region of mutual contact and action, the cellular surface feels the presence of the plastic liquid. It is more than wetted by that liquid (though the phenomenon of wetting is a superficial assimilation)—it is rendered plastic. The new cells are not added abruptly outside the old. Along with the formation of new cells there is a solution or absorption of old ones. The new and the old are beautifully wedded together; they grow and co-exist in harmony, in unity, so long as healthy development is the order of the day. Let it be otherwise, and not a case of health; let the concrete organism in the region of the plastic liquid lose its energy, or the plastic liquid gain more energy than is proper to it in health, and then the cellular surface, instead of growing or being redintegrated, will be dissolved away or absorbed into the liquid; instead of strength there will be weakness, instead of granulation and closing, there will be abscess and ulceration.

* See *Proceed. Roy. Soc., Edin.*, Sess. 1858–59, p. 146; *Proceed. Phil. Soc., Glasgow*, 1859, p. 52; *Report Brit. Assoc. at Aberdeen*, 1859; and as a separate work, *First Lines of Science Simplified, &c.* Sutherland & Knox: Edinburgh, 1860.

Disease is not the mere absence of health. It has positive power to extend and perpetuate itself, in so far as it is not in its own nature essentially temporary and transient. Disease cannot be met and resisted too soon, while as yet the healthy action of the system is but a little impaired by it. Hence the cause of so many deaths under acute disease; the physician is not sent for till it is too late. He is no longer master of his situation.

“But that by the way at present. What I have now to insist upon is this, that the instance of assimilative action which has now been given is but an illustration of a law which is absolutely universal; which, though not always obvious to the senses, either in its working or its results, yet is never wholly at rest, and holds good in reference to inorganic as well as organic nature. What but a phenomenon perfectly parallel, and to be referred to the same law, is the growth of a crystal, for instance, in a fluid medium, whether liquid or aeriform, when that fluid is losing energy as such, either through loss of quantity (evaporating), or of heat (cooling), while yet the number of concrete particles in it remains the same, so that, considered as plastic material for the increment of a morsel of a crystal or concrete substance of some kind immersed in it, or placed in contact with it, that fluid's condition is improving? And what but a phenomenon of the very same order with crystallisation is its counterpart, solution—that is, the reduction to a fluid form of any soluble or volatile substance in a fluid, whether liquid or aeriform, in which that concrete is immersed? In the former case the solid assimilates the liquid to itself; in the latter case the fluid assimilates the solid. In like manner, when a granular or crystalline nucleus or bed exists in, or is conterminous with, a mechanical rock, and the granular structure is seen to be extending from that nucleus or bed, what is this but an illustration among geological phenomena of the same law, the law of assimilation? Nor is it less an illustration when crystals imbedded in a rotten rock are found to be rotten themselves. Again, when two dissimilar gases or liquids are placed in contact, either immediately or with a permeable diaphragm between, and the particles of the one pass in among those of the other, as they are known to do, until they are completely diffused, and the mixture of the gases is complete, what is this but a case of assimilation, where the success, mechanically considered, is complete? Diffusion, osmose, capillarity, are but efforts towards assimilation. Catalysis is but the affirmation of the power of one molecule to act assimilatively on another. And what else is chemical affinity but the determination of molecules, when of essentially different types, and not immediately assimilable, to merge their differences by rushing into each other's embrace, and constituting a new chemical species? It is quite marvellous what order and simplicity present them-

selves in nature when we try to take as large a view of her processes as nature does herself, when we try to forget all laws which are merely empirical and have no reason in them, and to dismiss all fondlings and foundlings of our own. There is in nature, indeed, an all but infinite variety—a variety which appears in laws and ends as well as in forms and structures; but there is also an all-pervading unity; and the law of assimilation in its twofold function of at once perpetuating individualities and effecting universal harmony—the impress on creation at the very fountain-head of the two essential attributes, the immutability and the unity of Him who inhabiteth eternity and is the Author of all—the law of assimilation is the most deeply-piercing and all-pervading law of the cosmos that can be reached at present. It is, in fact, exactly an articulate expression of what all men feel when they think of Being and System.

“To find the place of the vegetable kingdom in nature, it is only necessary to consider that diffusion, osmose, capillarity, &c.—in one word, mutual penetration—does not take place between gases only, nor between liquids only, nor between solids only, nor yet between solids and liquids only, but also between aeriform and concrete media. It takes place between the air and the earth, the atmosphere and the soil, on their mutual confines. Yes; the air in contact with the earth tends to penetrate the earth, and to become assimilated to it by assuming a condensed or concrete state; while the earth in its turn, on the confines of the air, tends to rise into it, and become as aerial as it can. Nor can either do otherwise if the law of assimilation be as universal as it has here been maintained that it is. In obedience to this law, those earth-particles which are capable of the aeriform state must tend to rise into the air as gas or vapour; and those which are not volatile, yet separable from each other, must tend to effloresce into the air, and to constitute, on its confines, with the earth, lace-like mineral tissues as highly diffused, as spreading and elastic, as mobile and coloured—in a word, as aerial and bright as possible. I say bright as well as aerial, because the atmosphere is the realm of light and colours as well as of air.

“Has, then, let us ask, this cosmical disposition on the part of these great neighbours, the earth and the air, to keep the law and live in harmony together, to interlace their borders, and adopt as far as possible each other's substance and forms on their common frontier, been permitted to realise itself? Do we find that, on the mutual confines of the air and the earth, the air-particles seek downwards and become concrete; while the earth-particles, water included, seek upwards, and spread themselves abroad in the air? Yes; it will be immediately granted that the soil absorbs and retains in it a goodly portion of air and vapour. The earth also, it will be admitted, the more fully it is

exposed to the air, becomes more and more pulverulent—nay, often rises in clouds of dust; nay, of fish; nay, of frogs; nay, what not, utterly to astonish the natives by their fall again. Certain earth-particles, also (potass, lime, &c.), in places where the air is still, are well known to effloresce beautifully into the atmosphere, as if to anticipate vegetable nature. Moreover, the aqueous matter of the earth is ever tending to rise into the air as vapour. Yes; it is to the law of assimilation (as the rational cause) that we owe the existence of the cloud-world, so varied, so grand; and not less benignant than beautiful. For when it exists as vapour in the air, it is no less under the law of assimilation than it was when in the earth as water. And, in consequence of this having now gained the aeriform state, and satisfied the demands of the atmosphere, it is called upon by the earth to satisfy its demand under the same law, and to become assimilated to it in its turn—that is, to become concrete. And, accordingly, with prompt obedience, from its aptitude for the concrete state, the cloud-matter forms into little masses while yet on high; and pouring down as rain, and hail, and snow, it not only assimilates itself with the concrete earth as a concrete form, but it ploughs the bald surface into many a ravine, thus enabling the air to penetrate deeper and lock with the earth more closely. Meanwhile the earth, by secular upliftings, meets the cloud half-way, and, summoning to its aid the volcano and the central heat, rises high in Alp and mountain-range, keen air piercing into the deep valleys between. Thus that which to blind sensibility seems but the war of the elements, is to intelligence a harmony and a mutual embracing. The storms and convulsions of nature are the products of a law which has repose for its end and aim, and which is, as has been already stated, the symbol and representative in nature of the unity and immutability of the Deity. The law of assimilation by which a wound granulates and our organisation is redintegrated, by which our strength, physical and intellectual, is restored from hour to hour, is also that by which the surface of our globe, from being a bald geometric surface, is made rugged and hoary—that by which the beautiful, the picturesque, and the sublime are imparted to nature, and a sheltered dwelling-place secured for man and other animals.

“Nor is this all. By the miracle of creation at first, and by sowing the surface of the earth thereafter, with the seeds of plants, the Creator has enabled the earth and the air to fulfil the law of assimilation and harmony between them in a manner that is most complete and most beautiful. *For the fully-developed seed, the individual plant, the vegetable kingdom as a whole, what is it, when viewed in relation to the atmosphere, but air become concrete as vegetable tissue piercing down into the earth and rooting itself in it? And, viewed in reference to the earth,*

what is it but a system of earth-particles, aqueous, gemmeous, earthy, saline, suspended and diffused in air to the utmost by the concrete air-tissue (that is, the vegetable tissue) as a scaffolding; these particles, meanwhile, in so far as they are capable of the aeriform state, exhaling into the air in forms often fragrant, and always more aeriform than those in which they enter the plant? Yes; the calling of the vegetable kingdom, the charter of its existence with antecedent nature, the earth and the air, is to realise and fulfil the law of continuity, of harmony, of assimilation, on their mutual confines, (1) to carry up in forms as aerial as possible earth-particles, and to suspend them in a state of diffusion in the air when they cannot be made to vaporise into it, and (2) to carry down, in forms as concrete as possible, air-particles into the earth.

“And in this theory (along with that which gives the spherical superficies as the most general archetype of all forms that are the products of the physical forces*) we have a satisfactory explanation of the forms of the plant-world in general. Here we see why a fully-developed plant must consist of an aerial and a terrene part, of widely-spreading morsels of surface or leaves, supported, if need be, on radii as leaf-stalk, branch, and stem, and of deep-striking roots and rootlets. There is no longer room for wonder why plants and flowers, things of such beauty, should be so fragile and so fading, the sport of every blast. The plant-form must intercede between the fickle fleeting air and the fixed earth on their mutual confines. The plant must bring these heterogeneous elements together and reconcile them. And therefore, inasmuch as the air is very tenuous, elastic, mobile, spreading wide and rising high, while the earth is concrete, inelastic, fixed, and lying low, the plant which is appointed to represent both in itself, and each favourably to the other, must have a form that shall be tenuous, mobile, elastic, carrying up and distributing in the air such earth-particles as are capable of isolation and solution, as widely and as high over head as possible. It must, as an individual, be a wavy, fleeting thing. If it is to acquire stability, and to last for years, or generations, or ages, it must consent to the compromise of its individuality. It must have recourse to the principle of association. Many must merge into one. The phyton must become a branching plant or tree.

“That the plant-form, especially when an annual merely, must, from its tenuous and expanded character, be very liable to injury, is an inevitable consequence. But in creation, as it actually stands, is this an evil? Nay; to the very extent that the plant-world is easily destructible, it is suitable as food for a higher order of beings—beings

* See *First Lines of Science Simplified*, &c., by the Author. 1860.

possessing sensibility, and that sensibility so adjusted to their organisation that a state of organic well-being in them is a state of enjoyment to them; beings teeming in multitude—creatures such, that it may be truly said, in a high sense, that after the glory of the Creator himself, creation exists for their sakes.

“To our theory there also attaches a definite conception of plant-life and function. A plant, according to what has been shown, consists at once of an ascending and a descending system of parts and action; and for the full development of the plant, a corresponding amount of energy must be simultaneously imparted to both these systems and modes of action. If the proper earth-particles which it is the duty of that species of plant to raise and suspend in the air are wanting in the soil where it is put to grow, the plant has nothing to do, and it will not grow either well or long. And if light and heat, which energise the air, are wanting, all the peculiar phenomena of vegetable synthesis must fail.

“The ascending system of parts and action commences in the soil, and from concrete molecules in contact with the spongioles of the root, it takes up such as it can, analysing and reducing them more and more towards the purely aeriform state; thus resolving water into common vapour, common vapour into oxygen and hydrogen, ammoniacal compounds into ammoniacal vapour, and ammoniacal vapour into nitrogen and hydrogen; also decomposing carbonic acid into oxygen and carbon, at least if nascent hydrogen be present, so that the carbon, by union with the hydrogen, may be rendered more aeriform than it is by itself, and thus may form the basis of some Essence by which the fragrance of the vegetable kingdom may be added to the vital air which, in these circumstances, that kingdom must constantly tend to evolve. Add to these things and to this mode of action the elevation out of the earth towards the periphery of the plant, that they may be diffused and suspended in the air to the utmost, the fixed earth-particles of carbon or diamond, potassium, silica, phosphorus, calcium, sodium, magnesium, sulphur, iron, &c., and it will be seen how much the root-system of a plant has to do.

“But, for success in the accomplishment of this analytical function, it is wholly indispensable that the descending system which originates in the air and belongs to the leaf shall co-operate in energy; for as the ascending or leaf-system is essentially analytic, or in the interest of aeriforms, so this, the descending or leaf-system, is essentially synthetic, or in the interest of concretes. An atom of carbon will not leave those of oxygen with which it is combined in carbonic acid merely to fall down and clog the plant as soot. While the root-system solicits the oxygens and carbons to part company, and offers nascent hydrogen for union to both, it is the descending, the leaf-system, that which has light and heat as its

energising principles, that actually effects the exchange. The leaf-system calls for molecules still more and more highly compounded, for the construction of which, above all others, hydro-carbon is well suited. But how, it may be asked, shall highly compounded molecules be able to maintain their existence if originating in the leaves and destined to encounter in the plant the analysing system of action that is ever ascending from the roots? For this they must be able to fulfil one or other of these two conditions: *first*, they must escape out of the cells in which the analysing plant-action is going on, and get into places or vessels apart; or, *secondly*, they must possess in themselves molecular stability while in the plant. Now, under one or other of these two conditions, it may be shown that all the permanent products of vegetable nature fall. Wax, one of the mostly highly compounded of them all, even often gains the outside and reposes on the leaf or the fruit, as does also sugar sometimes. All essential oils, resins, alkaloids, crystals, &c., exist in cells, apart; while as to starch, it is a vegetable substance constructed in such harmony with the whole action of the plant, that it is no more to be expected that a fully-developed plant will break starch up, than if it were the acknowledged embryo of cellulose. It is otherwise with sugar. But these views cannot be followed up by the ordinary lights of the laboratory. With the single exception of the sugars, all the formulæ of the tectonic elements of the vegetable kingdom are uncontrolled and destitute of significance.

“Thus it is not the external forms and the chemical composition of the vegetable kingdom only which our theory explains. It throws great light upon the internal structure of plants. It not only leads us to infer that all the first and simplest plants, and all the first elements in every plant, shall be little hollow spheres—that is, cells, vesicles, or utricles; but it leads us also to expect that, as soon as this cellular mass can claim individuality, and constitutes a plant at once aerial and terrene, with both a descending and an ascending system, and therefore a combining or concreting, and an analysing or rarefying mode of action accompanying, the cellular matter, under the influence of the descending mode of action, commencing in the foliage, must, as it proceeds downwards, tend to concrete and combine into forms more and more continuous and dense,—as, for instance, into vessels, fibres, and encrusting matter, still increasing in quantity as we approach the terrene part or root. Under the influence of the ascending, the separating, and rarefying system, on the other hand, the mass of cellular matter must continually tend to separate and expand into laminæ, or leaves and cells with their walls, still more and more bright and aerial (as in blossoms in particular and parenchyma and the epidermis generally).

“Under the same state of things, it follows that the distribution of

woody (or concrete air) matter and of ashes (diffuse earth-elements) in plants and trees shall be the converse of each other. The woody matter, as the product of the foliage, and of the descending concreting system, will be found in greatest strength in the interior of the stem and root; the ashy matter or earth-particles, the product of the ascending system, in the periphery of the stem and of the entire plant or tree.

"That all these deductions from our theory are verified by observation, is too well known to require to be stated; and here let us conclude with a remark suggested by the last inference, which throws light upon a great question in high philosophy.

"It is well known, in accordance with what has just been shown, that plants and trees are aerial and light above, massy and strong beneath. Now, this fact in creation has usually, in common with others of the same order, been held to be fully explained by a reference to its expediency. It has been said that plants have been wisely made light and aerial above, solid and tough beneath, to the end that they may be able to support themselves and brave the storm. Now this undoubtedly is a good explanation so far as it goes; but from what has preceded, we find that it does not go to the root of the matter. From what has preceded, we find that the lightness of trees above and their solidity beneath is not a particular expedient adopted in their interest alone, for securing a special end in their behalf alone. We find that it is secured in the fulfilment of a grand principle—that it is provided for in an all-embracing law, in the framing of which this particular end and innumerable other beneficent ends were provided for. These ends may indeed be advantageously contemplated by us in detail as such. But if we are to look for such ends in every individual object in nature and in every organ, we are only preparing ourselves for frequent disappointment; for utility is not the point of view which ought *to rule* in our regards. In the natural as in the moral world, there is a higher principle than particular expediency or individual interest. There is a call all through nature, which is ever for order, universal order, the well-being of the whole. And accordingly there is in natural science a doctrine of *general homology* as well as of *special utility*. And truly wonderful it is to observe to what an extent, in the natural as in the moral world, multitudes of special uses and individual advantages in detail are secured as often as supreme law is obeyed. Hence the grand aim at once of science and philosophy ought to be, the discovery of supreme laws; and to this theme the preceding pages have been devoted in the delightful field of the vegetable kingdom."

CHAPTER XIII.

OF THE FORM AND STRUCTURE OF A FLOWERING PLANT.

It was subsequently to the publication of these papers which have been so largely quoted in the preceding chapter, that I first ventured to conjecture in my own study, and have now come to believe in the structure of the material element, which has been set forth in these pages. It is for us now, therefore, to compare that supposed structure with the observed structure of plants, and to see whether we do not discern in the very structure of the material element itself anticipations of what we already find in the vegetable structure.

The vegetable kingdom, in order to be understood, must be regarded in a twofold point of view, which may be designated respectively as physical and physiological (or more correctly biological). The physical point of view regards it as the intermedium between the earth and the atmosphere, embodying and representing both, and clothing the planet with living objects, in fixed situations, which the sunbeams may fall upon and expand, fructify and animate. Otherwise, it may be also regarded as an efflorescence of the sphere mimicked by the efflorescence to be seen on damp walls, nitre-producing fields, and hoar-frost generally, a nusus of the planet to extend its dimensions as reaction against that contraction of dimension which the secular gravitation of its constituent particles implies, and so to utilise the heat which is constantly being forced outwards. This conception of the vegetable kingdom gives it as consisting of vertical lines or a continuation of the terrestrial radii into the atmosphere. It gives the plant as an axis fixed in position. It gives the plant axis.

The biological point of view gives a conception which is precisely the converse. For this point of view gives that of an organism which shall concrete the carbonic acid emitted in the aeriform state by the animal kingdom, and expose that concrete in the amplest manner to the sunbeam, to the end that the carbonic acid in it may be resolved, first, into oxygen gas again, so as to sustain the respiration of the animal king-

dom, and, secondly, into carbon-containing tissue, so as to repair in animals the waste which respiration and action generally imply. Hence the vegetable concrete must be so formed as to expose as large a surface as possible, both for the most successful absorption of the carbonic acid that is floating about, and for exposure to the sunbeam or light of day, that that carbonic acid may be decomposed. In short, the biological point of view leads to the conception not of the plant axis, but of the leaf; not of the radiating stem, but of the foliage. The first point of view gives the axis, the other the equator, which, as is well known, are the skeleton of the sphere. And to what an extent the spherical tends to prevail in the vegetable kingdom has been already shown.

And now let us enter into some details. And as the anticipation of an elemental plant-axis, let us prelude with a structure consisting of three material elements united in a line. This is the smallest number in which individuality can be maintained; for it is the smallest in which the terminals are similar to each other, and therefore repulsive of each other, as also of others like them, and so can maintain itself as an axis, and not turn round into a triangular or circular form.

And as that of most easy genesis, and therefore most probable in nature, let the two terminal elements be those whose nucleus consists of 12 aetherial units, with 20 overlying them; while the middle element is of the other kind—that is, with 20 internally and 12 overlying. Now may we not remark at once, that in this simple structure we have already a prelude of the three parts, namely, fruit and root, with foliage lying between? Nay, more. Of the three elements, though all of them are intimately bisexual, yet, according to what has been advanced in a preceding chapter, the two supposed terminals are female as compared with the middle element, which is male. And here may we not say, what all the world grants, that it is fruits and roots which are productive of offspring as compared with foliage?

But according to prevailing tastes in science, it is more in order to say that a simple plant, when fully developed, consists of these three parts, the fructification above, and the root below, as terminals of the axis, and foliage lying between.

And, first, let us direct our attention to the fructification, in which, as it is free to uprise in the air and sunlight, individuation and ample development most fully appears; while the root, growing as it does in the soil and darkness, has to encounter continual embarrassments. Here, then, let us call to mind that the material element respecting which we are now to inquire whether the fructification of plants is in any measure precluded by it, consists interiorly or nearest the axis of 12 elements, and is here female in relation to an external layer of

elements which are 20 in number, and male in relation to the others. Now that typical flowers are bisexual, as our material element preludes, and that the female parts are next the axis, and the male parts disposed exteriorly or around the female parts, are most familiar facts.

Being to such an extent encouraged then, let us enter somewhat more minutely into the investigation. But here the difficulty meets us, which at this moment prevails through the whole domain of natural science, namely, our utter want of insight or ideas to enable us to say what is what. Science is not only very blind, but glories in its blindness. What has been observed, it is said, is everything; what has not been observed, it is said, is nothing. Such is the canon of reality. And after all, the fact is that this boasted observation is in every case merely interpretation, the entire value of which is regulated by the culture or no culture of the mind which receives the sensations, or, as it is said, "observes." In the present case the question is, what are really female parts in a perfect flower, and what are really male? To this no answer has as yet been given which is comprehensive of all the parts. Nor has any scientific view been given of what makes male, what female. But may we not say, that of "female" the characteristic is to be receptive, and of "male" to be communicative. As to the forms of sexual organs, when we look to the whole of living nature, they are so varied, both in structure and situation, and indeed in every respect, that no definition can be built on form; we can only look to function as has just been done.

Applying this test then to that organism which forms on the summit of a simple plant-axis, that is, the flower bud, we remark that the whole at first presents itself as a sphere or spheroid, or rather ovoid, as perfect as the mode of its nutrition (which is from one region only) will allow. Now, viewed in this state as a whole, a calyx with its contents, it is female; the calyx being receptive in a twofold sense—receptive with regard to its interior of the whole fructification which lies undeveloped in it as in a womb, and receptive with regard to its exterior also; for the exterior of the flower-bud or calyx is usually of a green colour, contains chlorophyll, and is receptive of the carbonic acid of the ambient atmosphere. The calyx, therefore, we regard as belonging to the female parts of the organism of the flower. That the carpels, with their intensely receptive stigmas and ovules, do so is generally admitted. And thus we find that the parts immediately around the aerial terminal of the plant-axis are female, the sepals and the carpels being both analogous and homologous parts.

But our theory, that these parts are possibly preluded by the interior parts or endosark of our material element, ought to enable us to go

farther. It leads us to expect that those parts, taken together with the axis which they surround, will, in a complete but simple flower, be precisely 12 in number, and these disposed in either of two arrangements corresponding to the two kinds of axis which the dodecahedron possesses. Of these two kinds of axis, one terminates above and below in a point formed by three edges, facets, or members of the polyhedron, leaving other three outside of them above and below alternating with them (see fig. p. 67). The other kind of axis has one facet or member for each of its terminals, with five members lying around outside of each, and these alternating with one another. Hence, according to our prelude, the normal number of calyx-divisions or sepals, or of ovary-divisions or carpels, ought to be 3 or 5. Now that nature verifies this anticipation to a remarkable extent will not be denied. It were possible, indeed, to carry the correspondence into a great degree of minuteness. But we are at present so completely in an ideal region that further details may be advantageously omitted here, especially as when the doctrine of abortion, non-development, partitionment of organs, &c., is introduced, there is no difficulty in squaring phenomena with the exigencies of any hypothesis.

Let us proceed then to ask now whether we find any correspondence in the number of elements in the outer layer of ectosark of our material element or element of true protoplasm, with those of the male parts in a perfect but simple flower. And here we have first to remark, that our protoplasmic parts are here not 12 but 20 in number, the 10 upper or interior being opposite to each other in couples, as also the 10 lower or exterior; but the upper 10 alternate with the lower 10 (see the diagram of the icosahedron, p. 67). Now were we to adopt the common view that the stamens only were male parts, the correspondence of nature with our theory would be abundantly verified, for the number of stamens in flowers are, in a vast number of species, 5 or 10, or 20 (or thereabout). But the view that the stamens or anthers alone are male parts, does not accord with the conception that the function of the male is to communicate, as that of the female is to receive. This conception includes the corolla also as male, and, indeed, the whole flower, except the calyx and carpels with their contents, as has been described. Thus, instead of being receptive of the carbonic acid of the atmosphere, like the calyx and the carpels when maturing and verdant, the corolla emits carbonic acid; instead of keeping the fructification cool by the decomposition of that acid and the emission of oxygen gas as the calyx does, the corolla, like the stamens, generates heat, which cannot but often be of great value for the maturation of the pollen. The corolla also plainly exists as a protection for the anthers rather than for the carpels, for as soon as the anthers have

fulfilled their function and fade, the corolla fades immediately afterwards. The lower 10, therefore, of the 20 supposed male elements in the ectosark of the true protoplasmic unit we regard as preluding the 5 petals with their 5 claws, or the pentafid corolla with its tube, &c. The upper 10 alternating with the lower 10 we regard as representing 5 anthers with their 5 filaments, or possibly 10 stamens in many cases of development. Into further details and possible modifications we need not go, because the idea of a perfect, and at the same time a perfectly simple flower, is an idea merely.

Nor need we show, as must be under our cosmical law of assimilation (for this has been fully done already in an empirical way), that the flower in all its parts must tend to be foliaceous so far as the conditions of existence and the law of the spherical and cellular will allow. I only add, that the cosmical law explains also the great expansion of the corolla, for the corolla holds the position of equator to the terminal axis of the plant or peduncle.

As to the colours of the corolla, which have been held to be so beautiful, they are chiefly expressive of the absence of chlorophyll in it. Their charms depend on their comparative rarity, which engages and pleases the eye. If all the fields and forests were yellow, or blue, or scarlet, or parti-coloured, like flowers, what would we not give for a green leaf!

Let these remarks suffice on the structure of a perfect yet simple flower as preluded by the material element itself.

Upon the whole, such is the verification of our view which the vegetable kingdom displays, that instead of summing up our deductions as to the two sets of female parts in a flower with the two sets of male parts between and around them, may I not just quote the following words, which form the opening sentence of Professor Balfour's "Manual of Botany," where he treats of the flower and its appendages: "The flower consists of whorled leaves placed on an axis, the internodes of which are not developed. This shortened axis is the thalamus or torus. There are usually four of these whorls or verticils. 1. The outer one called the *calyx*. 2. The *corolla*. 3. The *stamens*. 4. The most internal one, the *pistil*. Each of these consists normally of several parts which, like leaves, follow a law of alternation. Thus the flower of *Crassula rubens* [he gives a diagram, which has been copied in fig. 16 of our Plate] consists of a calyx composed of five equal parts arranged in a whorl; a corolla, also five parts placed in a whorl within the former and occupying the intervals between the five parts of the calyx; five stamens in the spaces between the parts of the corolla and consequently opposite to those of the calyx, and five parts of the pistil which follow the same law of arrangement." Such is the example of a

typical flower of this class which he gives. He adds,—“Again in *Scilla italica* the parts are arranged in sets of three instead of five,” &c. It will afterwards appear, when protoplasm is regarded as differentiated into those organic elements which constitute the actual bioplasm of visible animals and plants, that there is another though an analogous reason for the appearance, now of the number 3 and its multiples, now of the number 5 and its multiples.

Having said so much of the fructification of plants as preluded by the uppermost of our three material elements which we conceived to represent the simplest plant-axis, very few remarks will be made on the root preluded by the lowest of the three. Being similar to the uppermost, though bisexual like the fructification, it is to be regarded upon the whole as female or productive. But here the organism, unlike the fructification which expands in the thin air, the root is so beset in the closely-resisting soil that the development is very poor and embarrassed. In fact, it all usually remains in a self-diffusing or filamentary state, the only specific organ being the open or absorptive spongiolate on the top of the rootlets, corresponding to the stigma on the top of the carpels; the matter to be absorbed being, in the case of the root, free particles of plant-food produced by the soil around the spongiolate; and in the case of the flower, free particles of plant-dust or pollen produced by the plant itself around the stigma; the former providing for the growth of the developing plant, the latter for the development of the future plant. On this subject I shall only further refer to a communication which I read before the Botanical Society of Edinburgh, 13th December 1860, which was, I believe, published in their Transactions, and, at any rate, in *The Edinburgh New Philosophical Journal* for January 1861, entitled “The Theory of the Terminal Fructification in the Simple Plant of Ovules, and Pollen, and Spores.”

As to the middle member of our three elements in our plant-axis, which, of course, preludes the whole plant except the fructification above and the root below, nothing requires to be said beyond what has been said already, unless, perhaps, it be this, that while it is bisexual like the other elements, yet here the female parts are not internal as in the fructification, but lie on the periphery. They, therefore, prelude the foliage, which is at once peripheral and receptive or female—*peripheral* to this extent that on it mainly devolves the determination of the external form of the whole plant, and *receptive or female* inasmuch as it has for its special function not only to suck in the carbonic acid of the air, and thus render the whole plant pregnant, but to form a bud or quasi-embryo, each leaf for itself.

CHAPTER XIV.

THE SIMPLEST ZOIC FORMS AND FUNCTIONS ARE PRELUDED BY THE STRUCTURE OF THE MATERIAL ELEMENT.

IF we are to content ourselves with modern science (so-called) such as it is, though there is mystery on all hands, yet nowhere is there a spectacle more perplexing than that which nature displays in the field of the microscope. What multitudes of living things, call them protozoa, protophyta, or protista, or by any more special name, their forms, and even their skeletons, sometimes so exquisite, always so strange, and enjoying life surely,—those of them, at least, which move about so rapidly, so freely, so spontaneously, nay, shall we not say, so capriciously—and yet themselves, by all that the scientific eye (so-called) can make of them, merely specks of animated jelly or glue, without mouth or muscle, or nerve or organ of any kind! Their forms how strange, and their means of getting on how unaccountable, and how unlike anything which human ingenuity would have proposed for them! In a word, is not the entire field of the microscope to the eye, though enlightened by all that science has to say, a perfect mystery and a perplexity? Why in the last analysis do we meet with granules and cells on all hands and as the ultimate constituents of everything, both animal, and vegetable, and mineral? Why are these granules and cells at first, and so long as they are free and uncompressed, spherical? Why have cells, also, in these circumstances, usually a nucleus, often a nucleolus? And why do they come, manifestly after a delicate and difficult process of construction, to lose so soon these nucleoli, these nuclei, nay, themselves to be partitioned or to dissolve away? Those vibratile cilia, also, with which spores and ova, and the minutest organisms generally, are furnished as with banks of oars, and which seem to be so proper to every individualised organic element, that they are often found even where such element is impacted among others, and has only one free surface, and that in regions of the highest organisation, as for instance in the mucous membranes of man himself, what can their origin

and meaning be? The tentacula, also, and lasso-cells, and setæ which succeed the cilia, as the organisms to which they belong become more complicated, and which characterise all the multifarious races of polypes, &c., how do they come to be there? Is not one tempted to think, if not to say, like that king of Spain when contemplating the Ptolemaic system of astronomy, that if we had been consulted at the creation we could have suggested something more solid and better? The fact is, that with respect to all these things, and a thousand others, nay, the entire microscopic field, nay, the whole field of nature, there is at present on the part of many naturalists nothing but despair, in so far as the rational point of view is concerned. To account for anything, they maintain is wholly beyond our powers, and therefore that with which we have nothing to do. Let us OBSERVE, they say, with all possible accuracy and minuteness all the objects which we can succeed in bringing within the range of our eye-sight. Let us CLASSIFY them all, and assign to each its place in nature with all possible painstaking, according to the best classification which we can devise, and let us turn to economic account, so that they may add to the enjoyments of our own life, those of them which are suitable for this purpose. But having done our best in this line, let us be content to let them otherwise alone. We are ourselves rapidly passing off the stage of existence like the rest of them. Why attempt to give an account to ourselves of the reason of anything since we are sure to fail? Why give any encouragement to hopes or fears with regard to a future, which though they have hitherto played, and still do play such an important part in the development and history of humanity, are nevertheless to all appearance needless and vain?

Such are the views of not a few naturalists at the present time. Nevertheless, to these naturalists, provided they are true to their method, and do not succeed in involving us in the same despair into which they have fallen themselves, have we not much reason to be thankful? For since they admit into their belief nothing but what they see with their eyes, they are surely good for us to go by so far as they go themselves; and if they have good eyes to see with, and good fingers to separate the objects they look at, surely their testimony as to what they have found must be of the greatest value. So it would seem. At the same time, it is worthy of consideration, how much more easy it is to profess to follow this method of simple observation than actually to do so. Nay, taking into account the unavoidable quickness and suggestiveness of mind in all who have curiosity enough to devote themselves to such inquiries, it may be questioned whether this method is ever practically followed in its purity. And, especially, it may be questioned whether this logically elected ignorance of the so-called man of science is much better than the natural ignorance of men in general. It is all very well to talk about accurate

observation. No doubt it is the first essential to the discovery of reality. But after all, *observation*, as has been already stated, when it reaches the mind, though still retaining this name, is already *interpretation*, and its value depends entirely upon the mental culture of the observer. Now, how can we interpret anything in a satisfactory manner but in the light of reason? And how can we expect any interpretation of value, except from those whose minds have all their natural wits and intuitions about them? Now, among the foremost of these is a belief in God and in the intellectual system of the universe. A mind, therefore, which in this respect is either naturally defective, or by course of study, or of life, has eliminated from among its convictions these truths, which are among the most characteristic instincts of humanity, need scarcely be expected to see light anywhere but along those few lines of thought which, taken together in their focus, give an image on the retina. And where, let us ask, does this method, employing as it does the abnegation of the ceaseless affirmations and demands of reason, land us? What is that universe, the reality of which we are able to reach in this way? An irreproachable logic declares that, pursuing this method, what we find as possessing the highest and indeed the only certainty by way of external world, is nothing more than merely a possibility of sensations, and by way of ourselves, nothing more than a power or habit of spinning out these sensations into a thread of consciousness.* Yes, this and no more, for God and the universe, man and nature, soul and body, liberty and law, and everything! A possibility of sensation on the one hand, and a thread of consciousness on the other, that is all in all. Let us refuse, then, to indulge in such an unnatural and sterile suppression of reason. Let us rather listen to the anxious inquiries which she makes, and without an answer to which she will never be satisfied.

And to resume our development at that point where we have obtained the material element and the normal action of its aetherial atmosphere, supposing it to exist in a medium dissimilar to itself, and assuming that nebulae or shoals of such beings or things do actually exist in that ocean of the universal aether in which we ourselves on board of this world of ours, and all other worlds, are sailing, do we find, let us ask, anything that throws any light on the forms and structures of those wonderful microscopic objects which have been referred to? Although, when we are at the material element only, we are as yet at an incredible distance from everything that is visible, let us not despair of finding resemblances. The cosmical law of assimilation, implying as it does a general homology among the products of nature, and especially among those which are most adjacent to each other in the order of genesis, leads us to expect

* See J. S. Mills' Criticism of the Philosophy of Sir W. Hamilton.

among the least and first things visible, resemblances in form and structure, and mode of action to the material elements themselves. Do we, then, find anything of this kind in the air which surrounds us, which of all earthly things resembles the æther most? Do we find in this medium any objects such that the material element itself of which they are composed may be regarded as a preluding of them? Now to this, though not altogether a negative, yet only an equivocal answer can be given. Until lately, indeed, the answer would have been simply, No. Until lately it was supposed that the common open air was free from particles of every kind, except those of the gases and vapours which compose it. But now it is found that even the azure of the sky, and at any rate a certain blueness which common air displays when properly illuminated for the purpose, is in reality nebulous in its nature, the nebulosity being due to clouds of foreign particles in the air. These particles are, however, so minute as not to be otherwise discernible at present. Nothing, therefore, can be affirmed with regard to their forms, structure, and modes of action. But in connection with them, the theory of zymotic and infectious diseases which is most in favour is to the effect that these diseases are caused and propagated by invisible organisms which, however they may have originated, and whatever they may be like, can maintain themselves all invisibly in the air for certain, sometimes lengthened periods. In confirmation of the existence of such objects in the air, it is also well known that media suitable for the entertainment of life—vegetable infusions, for instance, nay, chemical solutions, provided they contain the organic elements—cannot be long exposed to the air before they are teeming with life. And since the living beings and things which thus make their appearance soon produce on their own part spores and ova of exquisite minuteness, capable of producing their like in the same or other similar solutions, the legitimate inference is that they are themselves the development of spores and ova absorbed from the air. Their observation in detail while they are still in the air would, of course, be impracticable. But, all things considered, plainly in so far as the atmosphere is concerned, there is nothing to discourage us from searching even in this small planet of ours, to which alone we have access, for minute objects resembling in some respects, it may be, that with which we have peopled certain regions of the celestial spaces. On the contrary, there is much to encourage us to proceed with our inquiry.

Here, then, let us turn from the atmosphere to the ocean, and its various immediate or mediate distillates, that is, the waters generally of the terraqueous globe. In them, let us ask, do we find any objects bearing any resemblance to the material element itself, that individualised object or species which we have found as the very beginning of the material

economy, where it lies on the very confines of the world of spirit, that is, of pure life? Yes, in reply to this it may be truly said, in general terms, that all the waters of the world—oceans, lakes, rivers, ponds, marshes, ditches, &c.—wherever there is nothing to prevent it, are all teeming with little beings and things all in motion, more and more of them still more and more minute being rendered visible in proportion as the magnifying power of the microscope is increased.

In this field, then, we may reasonably look for those moving forms which are simplest among such as are visible, with a view to mark whether there be any of them which still indicate resemblances to our primordial type of material nature.

It is true that when we have transferred our thought from the single material atom to any object which can by any means be rendered visible, we have, as has been already stated, taken a flight which, in point of interval, may be compared to the distance of our planet from the sphere of the fixed stars. The interval from a single unit of atomic weight to an object which is large enough to show anyhow in our eyes is inconceivably great. But still this should not, according to our philosophy, discourage us in a search for resemblances. For since, according to that philosophy, the material element and cosmical law are one and the same universally, nature must everywhere be consistent with herself, and resemblances between individualised objects ought never altogether to cease.

And hence, indeed, the possibility of a knowledge of nature, such as may be justly entitled to the name of scientific. Nay, hence a beau-ideal of the study of nature. For hence it follows that, by the acquisition of an adequate knowledge of any one typical and fully endowed object, a general knowledge of leading features in all is acquired at the same time,—a happy result, surely, for by such a state of things much of the life of the truly philosophical naturalist may be left free for higher pursuits than the mere classifying and naming of minerals, plants, or animals.

But to proceed. Among the simplest living creatures which become large enough in the field of the microscope to admit of any insight into them are, as has been stated, Gregarinida and naked Rhizopoda. The former, when fully extended, possess lengthened forms, but when they attain a state of repose, both become spherical, and are said to be "encysted," as represented in figure 1, which, as has been also stated, may also represent equally well the ovum of a highly organised animal. Here, then, we have an illustration of the cosmical law of material action, namely, that the spherical, as being the form of culmination under that law, is the limit of metamorphic action, and therefore the form of repose. And no less an illustration of the same law is the fact that the Gregarina,

when in a state of action, departs from the spherical in form, and becomes prolate or axial, that is, spindle-shaped or cylindrical, while other species when active become equatorial, discoid, or radiate (*Asteroidea*), and multitudes hemispherical or hemiform (*Medusidæ*, &c.)

As to the *Amœba* (fig. 16) when in a state of activity, in its protruding in any or in all directions filaments consisting of the same material as itself, and in fact, parts of itself, and in its also retracting these parts again when and where it pleases, and thus out of its own plastic body or sarcode extemporising legs and arms for itself, and moving about spontaneously, and laying hold of its food, for the assimilation of which to itself it also extemporises a stomach,—in these actions of the microscopic animal, and in these protrusive and retractile pseudopœdia, which are emitted from the protoplasmic body or nucleus, do we not see what we may call a *nisus* at repeating the structure and action of the material element itself, with its ætherial elements constantly proceeding outwards from the nucleus and returning in again? As to the *Gregarina* on the other hand, and *Entozoa* generally, such organism and action are not to be looked for in them, in consequence of the confinement which belongs to their habitat, which forbids all delicate projections from their bodies.

But more simple than these, and mirroring the single material element more expressly, we may regard those ova and spores, which the simplest organisms, both animal and vegetable, produce, multitudes of *algæ* for instance and *zoophytes* (see fig. 8). Add to these a vast variety of fully developed organisms, sometimes referred by systematic writers to the animal kingdom (fig. 14, *Actynophrys sol.*), sometimes to the vegetable kingdom (fig. 9, *Volvox globator*), many of them providing themselves with exquisitely constructed siliceous or calcareous skeletons or supports for their soft bioplasmic forms (see fig. 15, a *Xanthidium* or ovum of *Crystatella*); also *Foraminifera* and *Radiolaria* generally. While they are surrounded on all sides, or symmetrically, with fine sensitive filiform appendages always in motion, or tending to move, extensible or excursive and retractile, like the ætherial elements in the atmosphere of the material element itself, in none of these primordial animals, it is also worthy of remark, has a mouth been detected, any more than in the material element. There is no room for looking in them, therefore, for organs of digestion and assimilation. But these things we shall have to look for as soon as we proceed to consider the first stage of composition of organism, and thus make a step in the direction of visible objects.

That such composite structures are to be expected in nature, follows from what has been advanced, both as to the effects of respiration and of sexual differences. The former process we have seen to be exhaustive

of the matter of the element or organism that breathes. Hence elements which have breathed much have become dissimilar to those which have breathed but little. When, therefore, two elements which are thus related to one another meet, they will tend, under the law of assimilation, to merge their differences by uniting together, and giving rise to a new structure consisting of a couple. Now, of this coupled element we may affirm these things. Its form must be lengthened or prolate. It must have one eminent axis, and it must consist of two parts, one of which is *materially* stronger than the other, but that other *ætherially* stronger than the first; for what a material element loses as to its materiality or inertia by the long-continued action of its ætherial atmosphere or respiration, it gains in what may be called ætheriality or quickness. Here then do we not find already in this organism, consisting of two parts united, the prelude of the body and the head of an animal, the body being the more material, the head the more ætherial part?

And what will be the mode of action of the ætherial elements proper to the two atmospheres of the material elements in this coupled form? Plainly the excursions of those which lie between the two component parts of the coupled structure, and therefore about the middle of the form, can no longer radiate and return freely from and to their proper centres, as they did when the two material elements were separate and free. On the contrary, as they tend to meet each other in direct opposition, their excursions will tend to strike out at right angles to the axis of the coupled form, and thus to form an equatorial respiratory circle. Not that this respiratory circle will correspond in position with the middle of the form. The law of action and reaction implies that it will be thrown by the part which is materially stronger nearer that which is materially weaker than the middle of the form, that is, nearer the head. As to the extremities of the axis of this coupled structure, the ætherial elements there will be more free to perform their normal radiant and returning excursions. Thus they will prelude cilia, tentacula, setæ, &c., at the head and tail. But here also the law of action and reaction will tend to endow the head more fully than the tail with purely material organs (tentacula, arms, &c.), while it will at the same time tend to arm the tail more fully with more ætherial elements. Now of these we have seen that germ and sperm are ultimate products, and therefore testes, ovaries, oviducts, stings, &c.

The structure, therefore, to which we are led as representing a living thing such as would result from the lasting union of two material elements, may be something like this (see fig. 17); *a* and *b* are the united elements, *a* the more ætherial, *b* the more material, and therefore *a* the head, and *b* the body. Projecting from *a* there is a complete circle of vibrating cilia, or setæ, or tentacula, or ciliated tentacula, &c.,

ministering to the preservation (securing food, &c.) of the individual. Projecting from *b* there is a defective circle of cilia or setæ, &c., *d* ministering to the reproduction of the individual. Around the head or neck, or between it and the body, there is a circle of cilia, &c., constituting a respiratory apparatus, which considered as expiratory, is of course counterpart to the alimentary circle around the head, and therefore such that, if that around the head bespeaks a mouth, that adjacent to it, but beneath it, indicates an anus. Now, in such a structure do we not see the preluding of such living beings as many infusoria, wheel-animalcules, and polyzoa, cephalopoda, &c.?

But let us hasten to remark, that although even a single material element (since its nucleus contains a central cavity), and still more, a couple when united, may represent an organism with a stomach, yet no development of a mouth has yet appeared, or any other need of alimentation but that which the emaciating action of respiration implies. As the living organism becomes more composite, however, a mouth, intestinal tube, and cloaca present themselves. Thus a coupled element consists of dissimilar parts. Hence such couples will tend to unite again, and there will result more and more lengthened structures of extremest simplicity, and either rigid, or capable of wriggling. And may not these be taken as the preluding of bacteria and vibrios in the first instance, afterwards of worms in general?

But following the course of definite organisation, we are called upon to remark that, as soon as three coupled elements have united, thus implying two hinges, the structure is capable of obeying so far the law of sphericity, that it may bend round, and head and tail uniting, thus constitute an annular segment of a triangular complexion, consisting of six material elements, and possessing six systems of cilia or setæ, arms or legs, or projecting organs of some kind. Now, have we not here the preluding of the segment of a vertebra, or at any rate that of an annuloidal or annulose animal? (See fig. 18, which is a transverse section of an animal of this order.) But each such annulus, being equatorial or discoid, they will, when developing in the same region under the law of symmetry, apply themselves to each other, so as to form a tubular structure, that is, a structure defective at both ends,—that is, having both a mouth and an anus or cloaca,—provided the organism be developed free in the medium in which it exists.

If, again, it be developed where the first ring is attached to any object, it will have a mouth only, and that surrounded by a system of cilia or tentacula, or ciliated tentacula, as the case may be. And here have we not a preluding of a polype in general, a conception which embraces the animal kingdom in its simpler members to a vast extent?

And now we need not attempt to carry our zoic synthesis any farther

though it was desirable to carry it thus far, because while we had the respiratory function from the first, and even from it saw the necessity of an alimentary function, it did not appear till now how alimentation adequate to secure growth and development, as well as to repair the emaciation implied in respiration, could be effected. Now, however, we see how this may be secured, when a structure defective at one if not at both extremities presents itself, that is, a structure with a mouth leading to an internal cavity, with perhaps an anus also.

But let us not attempt to carry our animated morphological constructions any farther here, when we are dealing as yet with the true, simple, or undifferentiated protoplasm, not the bioplasm of the biologist compounded of hydrogen, oxygen, carbon, and nitrogen, &c., but the mother element of all these, and of the whole material system. It is also to be considered that the aims of general or merely geometrical morphology, (symmetry and sphericity) cannot be in any great measure attained by organisms, which are obliged to develop under the manifold restrictions of concretes confined to the surface of our planet. Thus the gravitation of the planet requires that the axis of the form, if it be of any considerable size, shall be either horizontal or vertical, the former alone being stable. Hence, in individualised forms most frequently, a horizontal axis with a bilateral only, instead of a radiant symmetry, as in most animals; and in those whose axes are vertical, a verticellate and hemispherical (rather than a fully radiant and spherical form), as in most plants. The genial sunbeam also acting at the opposite pole in space to gravitation, tends to lengthen the axis upwards in all vertical forms, and to differentiate the dorsal from the ventral aspect of organisms. And in a word, it is only among forms on which gravitation and sunshine have but little effect, that is, among minute or aquatic beings, whether ova or minute forms, that an obvious accordance with the general types of morphology can be expected.

It is further to be considered, also, that there are in nature comparatively few, either plants or animals, which are truly individuals morphologically considered, few therefore which can be brought to the test of the general theory of form. It has been long known that plants which have more buds, or rather more leaves than one, are composite individuals. And the same is true to fully as great an extent, with respect to animals when morphologically considered. Thus a simple form can have only one equator and one axis. But most animals consist of many equators, which, however, being placed in a column with their axes end to end, preserve unity of axis and of animal life, whence animals have usually axial or lengthened forms.

An axial or lengthened form is indeed necessary to their activity; for sphericity is the form of fulfilled cosmical law, and therefore of

repose. Hence it is aimed at by all animals with a long axis when they go asleep ; for in that case, they ever tend to form their axis as much as possible into a circle or coil. Hence, also, the life-long action of the umbrella of the medusa in the sea, and of the heart in the breast of the vertebrate. They are both more or less hemispherical or pyramidal, that is, half spherical only, and hence they never cease acting, and that always in the interest of sphericity. They are ever throwing the mobile matter on which they act to the other side of their base or equator, so as, if possible, to effect symmetry and sphericity,—in which, indeed, if they could succeed, it would secure to the elements of which they consist freedom from all future work, and their emancipation from the concrete into the aeriform state—to repose or dance in the sunbeam, till the call came to them to descend again and assist in constructing concretes again, to which our partiality is easy to be explained, since our own organs are of the number of such concretes themselves.

But to return. Pursuing the course of life in the preceding synthesis, I have proceeded at once from the biological prelude of a single couple of material elements, to that of three couples united so as to form a ring or an annuloid articulation. But here, may it not well be asked, shall a couple of single material elements be prevented from attaching a third, so that not three couples, but simply three units of matter shall form a circular system. It is certain that such a system will be stable in the highest degree attainable by three equal and similar forces merely ; for such a group forms the triangle of forces of statical science. And when to the three we add a fourth poised over the triangle at an equal distance from all the three, so as to form an elemental triangular pyramid or tetrahedron (see fig. Δ). Now this is a statical system of the utmost stability and intransmutability. But in the very degree that a material structure is stable and intransmutable, it is incapable of life. Here, then, we find the dead appearing among the living ; here we find our primal matter of creation, or true protoplasm differentiated, by the appearance in its midst of dead particles of an abiding molecular structure.



The Tetrad.

CHAPTER XV.

ON THE DIFFERENTIATION OF THE PROTOPLASM TREATED OF IN THIS
WORK, AND THE DEVELOPMENT IN IT OF THE ORGANIC ELEMENTS
COMMONLY SO CALLED.

IN all that has preceded, mere or pure matter itself has been regarded as the basis of life in nature, and that which constitutes the true protoplasm, when we attach to the name its etymological import. It consists, according to our philosophy, of units, all of which, when entire and uncompressed, are spherical in form, and every way equal and similar to each other, except as to the positions which they occupy in space. In this respect each material unit is differentiated from all the others; and on this fact, according to what has been advanced, the whole economy of material nature, whether considered in reference to synthesis or analysis, growth or dissolution, depends.

But while all the material elements are equal and similar to each other, each is, according to our views, differentiated as to its own structure, composed as each is of an atmosphere or dynamosphere of æther, and a nucleus which consists also of æther, but in which the ætherial elements are confluent into one, which thus becomes a material element; the number of ætherial elements so confluent being $12 + 20 = 32$, giving as lines of junction traces of the two most perfect of the Platonic or geometrical polyhedra—namely, the dodecahedron and the icosahedron, either superimposed upon the other, or symmetrically circumscribing or inscribing it, as these two forms are well known to geometers to be capable of doing reciprocally.

This hypothesis as to the structure of the ultimate material element, which no one probably for a long time to come, save the author, will be disposed to admit to the rank of a discovery, or perhaps to regard otherwise than as a creation of an individual fancy, has been reached by invoking the aid of that law to which the name of cosmical has been awarded, because to it alone, ever operating under the eye and fulfilling the design of the great Creator, who is always and everywhere immi-

ment to His creation, an appeal is ever made. If other physicists and naturalists indulge in laws of nature by the dozen, or the score, or the hundred, we admit, as the ground of them all, so far as they have a ground in nature, only one. And if by a constantly recurring appeal to this one, we can explain, and have in this and the preceding parts of this "Sketch of a Philosophy" explained, a far greater number of the phenomena of nature and the laboratory than have been explained otherwise by scores of laws, which are frankly admitted to be empirical, surely this is no slight claim for our law to be at least looked into with a view to its acceptance or rejection. But let it not be forgotten that for any great step such as this long time is required.

This one law, which is regarded as cosmical, I have named the law of assimilation, because the process so named by which our living organism is maintained from hour to hour, is a familiar example of its operation. It is to the effect that every individualised object tends to assimilate itself to itself in successive moments of its existence, and all objects to assimilate one another. The ground of it is, that the created substance or simple and pure substance of creation, has for its special function to manifest the Creator, and consequently to assimilate itself to His will and attributes in so far as the finite can assimilate itself to the infinite. Hence it is, in its own nature, wholly plastic or devoid of fixed innate properties, and wholly assimilative, both with respect to its own portions or parts, and to surrounding objects, and to its position in space, and (in so far as it is capable) to the mind of the Creator. And thus there immediately awake in the material elements, as I have shown in the preceding parts of this work, individuality and the properties of sphericity, elasticity, and inertia, along with a tendency to be assimilated as to place, or, as is commonly said, reciprocal attraction.

Hence, in the first place, the construction in the æther or realm of light of groups of ætherial elements, generating material elements such as have been described.

Hence, secondly, a tendency in the material elements, when previously distributed in space, to form into groups, in which their ætherial atmospheres may become completely confluent, while their material nuclei, being possessed of a more powerful individuality than ætherial elements, come into juxtaposition merely, thus constituting molecules.

Nor is this all that can be ascertained respecting them. By two impregnable arguments, one of them mathematical, and compelling universal consent, the other a legitimate deduction from the cosmical law, and therefore good in our philosophy, the forms and structures of these molecules must always be as symmetrical as the reaction of their own constituent particles and that of their surroundings will allow. Now, to the full extent that mathematics can determine the forms of systems

of equal and similar, elastic and reciprocally attractive spherical forces, or centres of force, when they have settled in a state of equilibrium, their forms are proved to be symmetrical in the highest degree. And the law of assimilation gives the same result; for symmetry is precisely the assimilation to one another of those parts or particles in a form, which correspond in situation on opposite sides of some plane or line or ultimately some one point in the form.

Moreover, this, which must be admitted to be a clear and distinct conception of symmetry, enables us to discover what is that form towards which symmetrical forms as such culminate; for that form must be the one in which the assimilation of the parts or particles in all situations are most fully assimilated to one another, and to a single point within the form. Now this plainly occurs in the spherical superficies or cell. And here, may I not ask in passing, whether all nature does not verify this conclusion, wherever she is permitted to do so? From the great orbs of heaven to the minims of the microscope, whether organisms or atoms of bruised granite, what have we, as the recurring form, but the sphere everywhere?

No; happily not everywhere, at least not the spherical and cellular in form, consisting of similar or homogeneous materials. For where that is the case in any object, the aim of nature in the construction of that object has been attained. Further activity in the previous direction has come to a close, and that object, viewed as it has been hitherto, has nothing to do but repose or to die.

Let it not be forgotten, however, that no sooner has death taken place on this account than the particles constituting the object, being now set free from obeying the law of assimilation as to *space*, and from constituting a part of a composite form (not their own), are free to obey this law as to *time*, and so to become again the individualised objects they were before aggregation, each entitled to occupy its own field in free space as originally awarded to it, that is, to become aeriform.

But though such a law there be, it does not follow that spherical and cellular objects shall meet the eye everywhere. As to objects placed on the surface, or anywhere out of the centre of a gravitating sphere (such as our world is), which is of course always drawing every material element towards its own centre, their construction by an aggregation of such elements into forms which are themselves spheres, especially cellular or hollow spheres, cannot but be very difficult, in many cases impossible, and in many indefinitely postponed.

But hence two most interesting results—first, a ceaseless and indefinitely continued activity in matter; and, secondly, a definite direction of that activity—that is, a life and a morphological aim—or, in one word, a definite economy of nature.

As to the character of that economy, when viewed metaphysically, it may be said to be the attainment of repose ; and when viewed physically, to be the construction of the most perfect of forms ; for such, under many points of view, the single-walled sphere undoubtedly is.

In this work I have first taken into consideration the structure and action of a single material element. And in the structure which has been assigned to it we have seen, as we should expect under the cosmical law of universal assimilation, implying as it does a homology reigning through all nature, the origin and cause of many of the first, and strangest, and otherwise most unaccountable facts in biology. Thus, in the *structure* of the material element itself, we have seen the type and prelude of such structures as nucleus and nucleolus, female and male, endosark and octosark, &c. ; such organs as cilia, tentacula, limbs, &c. ; such beings as locomotive spores and ova, Rhizopoda, &c. We have also found in the material element itself the reason why certain numbers are recurrent and prevalent in organic nature, both animal and vegetable. In the *action* of the material element itself also we have found a prelude of the grand function of respiration in general, and in detail an anticipation of such institutions as lasso-cells, various kinds of spitting and exuding, as also tegumentary appendages, &c., these things when looking to a single material element.

We have also, though very shortly, considered the case of two material elements united into one. And in this we have seen a prelude of such beings as infusoria, nay, much higher organisms considered as forms merely, as also the differentiation of an animal into a head and a body.

We have even touched upon the case of three material elements when united into one. And here we have found morphology opening into two branches, one corresponding to that in which the three constituents continue are united in the same line or axis, the other that in which they bend round upon the two hinges which the union of three implies into a trigonal or annular system. And here, corresponding to this deduction, when we looked to nature we found rising out of organisms which may be conceived to belong to either line according to their time of life, the vegetable and the animal kingdoms, the straight axis composed of three material elements superposed on each other, representing the plant-element, the annular system of three representing the true animal-element.

Such annuli, in fact, being applied to one another on the same axis, there is precluded that structure of the animal axis, which manifests itself almost from the beginning onwards even into the vertebrata, the highest of terrestrial organisms. The characteristic of the whole series is a continuously hollow or tubular body, which has two mouths, or a

mouth and an exit-opening, or, at any rate, a structure which is in want of matter or food to complete its form.

And here the question arises—given our elemental annuloid, or mere triangle of matter, how can food be prevented from placing itself axially as two similar poles (for both are defective in matter), as the law of assimilation would seem to imply that it should; in other words, how shall the two open regions be differentiated, the one as mouth, the other as anus? This is a question very interesting, no doubt, but which it would be preposterous in us to enter upon now, while, as yet, we are dealing with homogeneous undifferentiated protoplasm, the primordial element merely, in which neither hydrogen nor oxygen, nor any of the organic elements, commonly so called, have, as yet, been secreted or have otherwise made their appearance. Before addressing ourselves to it, therefore, let us see what must happen on the simplest possible conditions, and while as yet, elemental synthesis, the demonstrated propositions of statical equilibrium, and the law of symmetry or assimilation may still be a safe and certain guide. This inquiry will, moreover, bring us into the region of well-known terraqueous substances, and first of all into acquaintance with

The Aqueous Element.

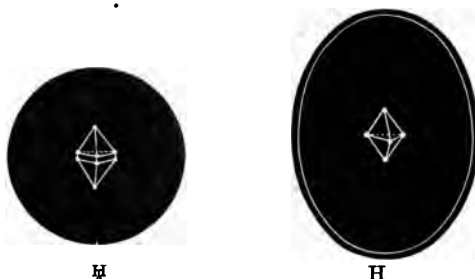
What we have to set out with in the biological point of view in which we are now contemplating the synthesis of material elements, is a system of three such elements arranged, not as a linear or axial system, but as bent round and forming a circular or closed system, the extreme stability of which we have already seen when it was statistically considered as the triangle of forces, but which we now consider as an elemental annulus or element of a flexible tube or annuloidal body.

And here we have first to remark, that two such triquetro-annular bodies meeting in the same field will conjugate; for a couple in union on the same axis, viewed in reference to the ætherial atmospheres, now supposed to be resting on each other, must be more nearly spherical than one only, for one is merely an equatorial ring, whose form overhead (that of its atmosphere) must be a very oblate spheroid.

But before they conjugate such Desmidia-like elements must also exist single at least for a time.

In a mass or medium, then, consisting of true protoplasm, that is, of merely material elements, not differentiated otherwise than each is in its own intimate structure, let there be developed a greater number of conjugated trigonal annuli such as have been described, and along with them a smaller number of similar annuli still single. Of both it is to be observed that they are similarly defective in matter on both extremities of their axis. But this defect, a single material ele-

ment or particle of protoplasm, by placing and poising itself symmetrically over both ends of the axis in both cases, can supply in perfection. There will thus be developed two molecular structures, the nuclei of which we may thus represent in diagram and literal symbol.



I have elsewhere shown (see P. II. p. 46; P. III. p. 14) that both these bodies, if free, must be intensely stable, undecomposable, and untransformable and what they represent in the laboratory. But what we have here to remark is this, that by their secretion thus, in the course of a biological synthesis or growth, these two bodies call a halt in the march of universal life. For when we say of an individualised structure, that it is alive, what we imply is that it is unstable or mobile, decomposable, transformable. Our Hf and H , therefore, which are similar to each other in many respects, are similar also in this that they are dead, at least when considered as existing alone and free, and at such temperatures as are to be found on the surface of our planet. This limitation as to temperature is necessary with regard to H , for, although, when free it must always maintain the form of a trigonal bipyramid, yet it is also capable of assuming what may be called a coronal form, in which its five constituent units come into the same plane, defining the five points or angles of a pentagon. On this, however, I need not enlarge here. But while Hf and H are similar, they are also dissimilar to one another, and this it is important for us to remark. For, hence, they will tend to unite together! And since atoms of Hf are more abundant than atoms of H (for of all stable structures the elemental tetrahedron Δ is the simplest, and Hf is merely a symmetric couple of elemental tetrahedra) atoms of Hf will gather around atoms of H . As to the resultant combination, that will obviously depend on the number of regions in the atom of H , which are suitable for the attachment of atoms of Hf . Now these regions are obviously 5, three on the equator and one on each of the two poles. As the product of the aggregation, therefore, of H and Hf , we shall have a combination, which is expressed by the formula—

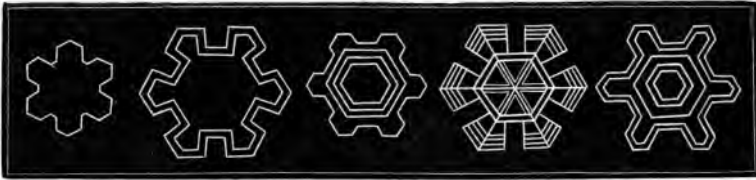


It is so polymorphous that it would take long time to describe and many diagrams to show the various forms in which it may possibly exist. But there is one of these which transcends all the others in symmetry, sphericity, and compactness, and therefore in stability under trying conditions of existence. This, therefore, we may regard as the natural and characteristic form, at least when the temperature is not such as to develop the most highly-expanded form; and this we may regard, therefore, as the biological form. It is when all the six constituent members of the structure place themselves so that their equators are all in one plane, an equatorial angle of each being in the centre. They are all nearly isamorphous, and the equator of each is an equilateral triangle. The equator of the group is therefore a regular hexagon, composed of six similar triangles. And over each of them in both sides a material element is symmetrically poised, giving to the whole a structure of exquisite symmetry. But it is as defective on its axis as are the original annuli or triangles of forces of which its equator consists, or, as we might say, it has two open mouths. Also, instead of possessing a cellular or centrally empty structure, its centre is its most loaded part. Symmetrical and beautiful, and in some respects perfect, though it be, therefore, it cannot be an ultimate as well as a primal element in nature. Meantime let us here give its diagram and a literal symbol (which we will afterwards justify).



aq.

But what have we here? This structure the iron hand of a synthesis, guided by the inexorable laws of statical equilibrium has forced us to construct and to accept. And to it we must reconcile ourselves, however strange and unlike anything that we meet with in nature it may be. But is it strange, and unlike anything in nature? Nay, can any one look upon such a structure without being reminded of the first concrete forms of the aqueous element—that element which, by the vaticination of all philosophy, has been deemed to be primeval? What will result from the symmetrical aggregation of such structures but the actual forms of snow flakes? Are we not also reminded by it of the



Snow Flakes.

flowers of endogenous plants, that is plants in which it may be said generally that the aqueous prevails over the carbonaceous tissue?



Endogenous Flower and Seed-Vessel.

But these resemblances by the way at present. Here let us ask, in the first place, respecting it, whether, supposing a multitude of such to exist in the neighbourhood of each other, they will continue always to exist separate, or whether they will not rather, under increasing cold or pressure, run together into a molecule of some kind? That the latter alternative must represent the case may be gathered from inspecting the form of the structure itself. Thus, of the six parts which constitute it, one is an atom of H , while the other five are atoms of H . The structure is therefore differentiated, and in virtue of this, as an individualised body, it will cohere or continue in union all the more firmly.

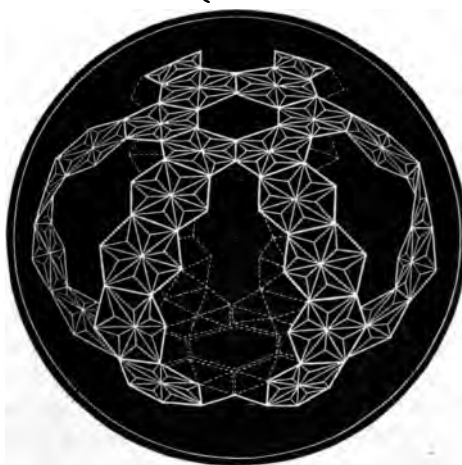
But, for the same reason, one of the six sides of its equatorial region, or region for union, is dissimilar to the other five. Hence, when two or more, through cold or pressure, come near enough to one another they will assume positions in relation to each other, such that the repulsive action of the similar elements shall be a maximum and in equilibrio, and the dissimilar elements, consequently, nearest to each other, and most favourably placed for clapping together as soon as the ætherial atmospheres of both, or of all, will permit. A medium then containing sparse atoms of aq will be liable to change, and an aeriform medium composed of such atoms will, under increasing cold or pressure, tend to condense. And, plainly, it would be a great step if we could ascertain the forms and structures which will result. We have this to guide us

in the inquiry that, as to the resulting molecules, like all others, they must tend to be spherical.

Now, here we are met by the fact that the equator of the molecular constituent aq, which is obviously the region of quiet or cool union, is a hexagon; while this is such a form that, when hexagons are continuously united together, they cannot form a definite polyhedron at all, but only a linear series or lamina.

Here, then, we find the first differentiation of an undefined mass of protoplasm which our philosophy gives. From having been homogeneous, it will now lie traversed by lines and laminae, and, in fact, be differentiated into a tissue consisting of true material elements held together by fibres and membranes of aq. And have we not here the prelude of those jellies, both vegetable and animal, of which, when the contained aqueous matter goes off, almost nothing remains, however large they were before?

But differentiation and individuation must tend to go on. The atoms of aq must tend to segregate, and thus to grow together under the law of symmetry, and become individualised as they may. And here let us ascertain, if possible, what must be the form and structure of the smallest number which possesses good morphological conditions of existence. Recurring to the lamina (which it is the characteristic of hexagons when grouping together), the smallest which fulfils the condition of symmetry is when 3 place themselves on alternate edges around one in the centre. And when on this central one, other two place themselves one above and the other below, so as to form an axis of 3aq to the lamina of 4aq as the equator, we obtain a molecule which has a certain claim to existence. It consists of 6 atoms of aq, 3 ex-



$$AQ = aq^{36}$$

panded laterally like petals, and 3 standing in the axis like an ovary, each composed of course of six parts, so that it may be regarded as a distant prelude of a monocotyledonous, say an alismal flower. But such molecules, consisting of 6aq each, must tend to run together again, and that in groups of six again, as the smallest number that the law of symmetry permits. And now having obtained a group of hexagonal structures, consisting of six times six members, they may attain to a higher unity and at the same time develop an exquisitely spherical molecule of a capsular nature constructed of six ribs or meridians, each consisting of 6aq, and united with one another at both poles. See on p. 144 a very defective diagram of it.

Here then, in our protoplasmic body, already differentiated inasmuch as it contains filaments and laminæ of aq, though, like itself, wholly hyaline, we find a tendency to a further differentiation in the construction within it of molecules or spherules of $AQ = 36aq$, which, no doubt, as to the eye will be equally hyaline or transparent. Now, in such a structure of the whole, have we not a prelude of the structure of such protoplasmic beings as sponges, &c.?

And now, suppose one of these contained spherules of AQ to leave the body in which it has been generated and to exist free, let us ask by what generic name we shall call it. And, in the first place, shall we regard it as inorganic or organic, as dead or animated?

That it must be held to be of an organic rather than of an inorganic structure follows, I think, from this, that it is a truly individualised body, constructed symmetrically, its exterior dissimilar to its interior; by which last feature it is distinguished from a crystal or crystalline element. But instead of pressing this inquiry further, since the idea of organisation is always associated with that of life, let us ask whether we ought to regard it as dead or animated. Now, here again we are troubled by the same indefiniteness and obscurity which attaches to the use of terms of everyday life when transferred to exact science; who knows what he means when he speaks of the difference between deadness and animation? Let us not attempt to settle it. But giving up that to lexicographers, let us state some of the properties of our capsular structure AQ, and leave the reader to determine for himself the category in which he will place it.

Looking then to nature with a view to discover something like it, one is at first disposed to say that it is the very prefiguration of a Beroë with six ctenophores.

But a further inspection shows, that though the intimate action of the material elements, as the summits of the six times six atoms of aq, which form the meridians or ctenophores, may be very great, yet that action can only consist in vibration, or rather pulsation, all round the

whole form, and that in the direction of radii to that form, or else in gyrations at right angles to these radii. That action can therefore only be calorific, not locomotive. But of such a structure as aq or AQ , it may be remarked, that the amount of pulsatory action proper to its constituent atoms, even at a low temperature, must be singularly great; in other words, what ought to be called its specific heat must be singularly great.

As to the form of AQ , it might also be shown that, according to the amount of pulsatory action or heat which actuates its constituent elements, that form must be either spherical or oblate or prolate. It must be spheroidal, on opposite sides of the spherical, corresponding to risen or fallen temperatures, and therefore its volume must be a minimum at a certain temperature, namely, when AQ is spherical, with increase of volume both above and below that temperature, a state of things which reminds us not of any organic form commonly so called, but of water, which, however, usually constitutes not less than $\frac{1}{4}$ of every organic structure, and often a great deal more, sometimes almost the whole, as in Berce, &c., already alluded to.

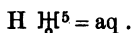
But in all this, whether its great amount of specific heat, or its changes of form with changes of temperature, there is nothing that would warrant us in regarding it as animated. Life implies the power of internal change, without dissolution, to a far greater extent than this. And if it imply dissolution also, then that, not without the previous or simultaneous production of spores, ova, or embryos of some kind, which may reproduce the life of the parent.

Now, this power of reproduction, which has been commonly regarded as a characteristic of life, we have here in perfection. Our AQ at a certain temperature or on diminished pressure breaks up in 36 atoms of aq , which separate from each other. And may not this be regarded as a preluding of what is seen to take place often in animated nature, as, for instance, in the mature monad, when it breaks open and gives birth to a multitude of little ones?

But is AQ capable of such change of form as may be observed in species all through living nature, whether plant or animal? This is the question for us now, most interesting, not so much for the solution of the question whether we are to regard AQ as in some sense animated (which after all is very much a question of words), as for bringing us to know what AQ actually represents in nature.

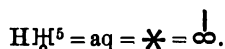
And here plainly, in the first instance, we must direct our attention to the atom of aq , by 36 of which a molecule of AQ is constructed. Now, this aq we have already seen to be composed genetically of two somewhat similar structures, namely, H and Hf , and to be the product of the

complete saturation of H by H^6 in its most symmetrical form, the equation being—

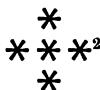


Now, though aq (see the diagram, p. 142), in virtue of its differentiated structure, cannot but be possessed of a certain amount of stability greater by far, for instance, than would be possessed by a similar form if composed of H^6 or H^6 , yet it is obviously tender. The atom of H in it is not symmetrically placed in reference to the $5H$. Moreover, aq is wholly deficient in an axis. Hence, if $5H$ be capable by themselves of constructing a symmetrical and stable molecule, while one atom of H may form an axis for it, such a transformation of the atom of aq may be expected often to occur.

To illustrate this, and to save the multiplication of bad diagrams, and to use types which are already in the hand of the printer, let us take $\star$, a star of six rays, to stand for aq ; also I or a dash placed vertically or horizontally, as it may be, to stand for H; and ∞ or 8, figure eight, horizontal or vertical, to stand for $5H$ in the new form, which, along with an atom of H, is anticipated from the transformation of an atom of aq . Thus we shall have as identicals in equivalent symbols—



Let us suppose, then, that we are to follow the changes of the structure of the group of $6aq$ which we supposed to form the first step in the genesis of AQ , and that, when there is no more aq present, and when, consequently, AQ could not be developed. In this case we may use the symbols just adopted, for any kind of representation is very difficult to draw and expensive to cut in wood, or otherwise produce.



Three of the six atoms of aq are in the axis of the combination, standing on each other's hexpartite poles, the other three (only two of which appear in the diagram) form equatorial expansions or wings. The latter at present we may neglect. But looking to the former, and inspecting the state of this axis as to unity and solidarity, it may be easily seen that is very badly constituted. In fact, the sustained pulsatory action of the summits of the two extreme atoms of aq against the summits of the middle one and its action against theirs, must tend to throw the atoms of aq off from one another, and so to dissolve the structure. Now, such a dissolution would be prevented if in each of

the two hollow or negative poles of the central atom of aq an atom of H were inserted; for in that case all the three atoms of aq would, in a manner, be bolted together. Now, such a position and purpose, the two atoms of H in the two extreme atoms of aq, in the structure of 3aq, can supply. But having supplied them, there is left on each pole of the structure not an atom of aq, but 5H in connection with one atom of H now in an axial position. Can these 5H then symmetrise and construct themselves into a stable molecular element? Yes, that they can; and in either of three ways, whereof that which

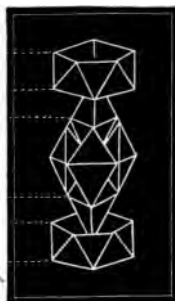
Oxygen ∞ .

is appropriate to the present situation is when they apply themselves to each other, by their alternate facets, and poles to equators, that is, by their most dissimilar parts. This done, they construct a molecule of remarkable morphological properties, which in point of general form may be compared to a coupling joint or wheel with a broad tyre in mechanics, or to a blood-disk, or a life-buoy (see fig.).

The transformed structure of three atoms of aq, united or standing upon each other on the same axis, will now give a new structure, of which the central atom of aq alone is the same as before, and of which some idea is given by the following diagram, which may be regarded as representing the ultimate resultants of the elemental forces which constitute matter.

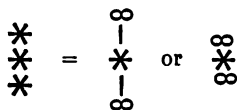


HO



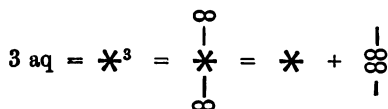
3aq = OHaqHO = 3HO

Using common types as proposed, we obtain the equation—

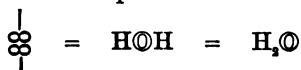


the atoms of H in HO on the formula on the right hand being supposed to be concealed between ∞ and $*$.

Now, this new form of 3aq, as well as 3aq itself, is obviously capable of decomposition, though not so easily as 3aq. The two atoms of ∞ , each a transformed atom of aq, are capable together of forming a symmetrical, and therefore a separately insulable molecule. And thus we may have as the equation of partial decomposition of the above—



Moreover, the last, which is a coupled atom of transformed aq, may also obviously be decomposed. Using a double-faced letter $\odot$ as meaning a couple of atoms of O in union, to stand for the central structure ∞ , we thus obtain the further equation—



And now let us ask, Is there any molecule known in nature or the laboratory which this $\odot$ of ours may represent? We can already compare it with aq and H. Perhaps they may explain each other. Now this they do in certain important features. Thus, as to the number of material elements or units of atomic weight which go to constitute H and $\odot$ respectively, the following facts appear. In H there are 5, and in $\odot$ there are $2 \times 5 \times 8 = 80$, or, calling the atomic weight of H = 1, that of $\odot = 16$. In atomic weight then our structure which $\odot$ stands or agrees with an unit volume of oxygen as compared with hydrogen gas.

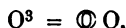
And since the law of assimilation leads us to expect that the unit volumes of individualised molecules, when in the same state, will be equal to one another, the product of the decomposition of any measure, say two volumes of aq, will give the same measure, say two volumes of H, and half the same measure, say one volume of $\odot$. Now this is well known to be the fact when common vapour is decomposed into hydrogen and oxygen gases.

As to the corresponding weight of the smallest unit-volume of aq when in the aeriform state, since it is equal to HO, it must be $5 + 40 = 45$, when H = 5 and $\odot = 80$, i.e., 9 when H = 1. Now this is precisely that of common vapour, its unit volume under the law of assimilation being held to be the same as that of H and $\odot$. And not only do these deductions explain the known phenomena of chemistry, but they bring along with them great relief to that science from great embarrassments. During the earlier period of the



$\odot = \text{O}_2$
Oxygen Gas.

atomic theory, the atomic weight of oxygen was generally taken at 8 when $H = 1$. It is now generally taken at 16. Meanwhile the phenomena of ozone have come in to make the darkness more visible. Now ozone, in all its features, especially in its characteristic, namely, its more intense chemical activity, is fully explained by the view here advanced; for, as the attainment of the spherical is the attainment of the aim of molecular action, it is the condition of molecular repose or inactivity, whence a single atom of O, being much more defective as to sphericity than a coupled atom, that is, than an atom of $\odot$, must be much more active. Not that any of the ozones (for there are more than one of them) consists of oxygen in single atoms, but they are all molecular structures of oxygen in which there is an odd atom of oxygen, which is on the eve of going off as a single atom on any change of action. Thus one of the best defined ozones is that whose sp. gr. is $1\frac{1}{2}$ times that of oxygen gas, indicating that the aeriform unit is that which is normal to sulphur when it assumes the aeriform state, that is, consists of three atoms of O, giving the equation—



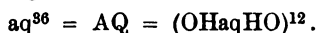
speedily resolving itself into oxygen gas and active oxygen. (But for a more dense ozone, see Part II. p. 93, note.)

That oxygen in every case, $\odot$ as well as O, must be very active, follows from its extreme defectiveness in reference to the sphere. And that that activity must manifest itself chiefly by a generally parasitic or corrosive habit, follows from the fact that it is in polar matter that it is deficient. Hence, it will tend to squat down upon and adhere to almost every other body, for it can scarcely be so ill anyhow as when existing alone.

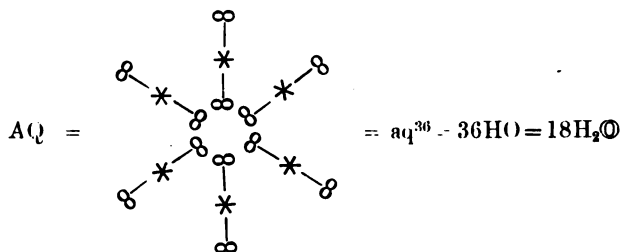
The morphological relation of O to H is also such, they are so entirely dissimilar, that when they are brought within the sphere of each other's attraction, they must rush together with immense force, the positive axis of the atom of H in the direction of the negative axis of the atom of O, piercing O, and causing such heat as must tend to explode it, the explosion being prevented, however, by the suitableness of the atom of H to take its place along with the 5 atoms of H^5 , which constitute O in constructing an atom of aq, towards the regeneration of which the whole action tends, inasmuch as it tends to bring all the axes of the six nearly isomorphous members of H^5H^5 into parallelism, and into the same plane; for such is the condition of the six members in the beautiful structure of aq.

But, referring to the former parts of this work for evidence showing how completely our molecular structure of H and O and aq explain all the known phenomena of hydrogen, oxygen, and the aqueous element,

let us here remark, what now appears, that our Beroe-like AQ (see fig. p. 144) is capable of a remarkable transformation. In fact, every three atoms of aq that enter into it may resolve themselves into the beautiful structure, of which the lines of the resultant forces are given in the diagram (p. 148), as has been already shown. Now here, both poles being atoms of oxygen, they are pentagonal, and not trigonal, like those of H and H^+ . They cannot, therefore, run together into hexagons, and thereafter tend to form filaments and membranes only, and if spherules, then spherules still very open, though with no fewer than 36 atoms of aq in each. They are now altogether suited for forming a regular polyhedron, one of the Platonic bodies, the dodecahedron, namely, consisting of 12 members. Now in each of these members there are 3 aq. One molecule of AQ, therefore, gives precisely one such dodecatom :—



To represent this beautiful structure in detail must be left to hereafter, when there will be students of these matters who can afford to lose, or have skill and a mind to make money by science. Meantime, with common types, it may be half shown as if it were in profile ; thus—



Thus our first complete differentiated structure in our primal or true protoplasm is capable of a remarkable transformation. Formerly, as AQ, being once free, it was capable of maintaining its freedom by the great heat and repulsiveness which must ever tend to actuate its whole surface. It was also capable of changing its form from prolate or lengthened to oblate or discoid, with spherical lying between. Now it must remain always spherical. And this may be remarked respecting it, that, being already wholly mailed in oxygen, both outside and inside, it is protected from the further attacks of this, the great terraqueous corroder. But it has at the same time, and in virtue of the same structure, become parasitic or adhesive on all sides. Such dodecatoms will, therefore, no longer remain free. They will tend to unite, though not with each other directly perhaps, yet with other matter. And thus they will induce, as we shall presently see, a further differentiation of our elemental protoplasm.

But have we not in this $(\text{OHaqHO})^{12}$, as compared with the same

matter as AQ, a preluding of the hybernating, or encysted, or ovulated state of organisms? And if it would not do to say that our aqueous spherule is an animated thing, can we fairly say that it is altogether dead? For my own part, I never can look at a stream of water rushing down from the mountain, or a river making for the sea, or a cloud forming in the air, without feeling that language is misapplied when the liquid element is spoken of as altogether dead.

But to pass from words to things, it may be remarked that, according to these views of the nature of the aqueous element, a most remarkable fact appears in its pathology. And that this must have important bearings in pathology, commonly so called, and therefore possibly in therapeutics, cannot but be, since our fleshy parts consist of aqueous matter to the extent of not less than three-fourths of the whole, and our brain of a still larger proportion. I allude to the great difference in capacity for heat between AQ and (OHaqHO)¹². The former, in fact, is more suitably constructed for entertaining a great amount of that vibratory or pulsatory action wherein heat consists, than any other molecular structure whatever. All the polar elements in every atom of aq that goes to construct it are free to pulsate without interference. In the latter it is quite otherwise. The same polar elements are to a great extent bound up. The capacity of the atom of O also (of which there are no fewer than 24 in the dodecatomic molecule) is very small compared with that of aq. When both are at the same temperature, therefore, that is, when there is an equilibrium of calorific action and reaction between them, according to their respective capacities, as structures composed of perfectly elastic elements, the quantity of developed action in AQ must be very great compared with what it is in (OHaqHO)¹². Aqueous matter, therefore, in passing from the former state to the latter must give out a great deal of heat, and so cause a hot fit in the organism in which the transformation takes place. When undergoing the contrary change, it must cause a cold fit, and that in both cases, all independently of the chemical union of carbon or hydrogen with oxygen, to which alone the phenomena of heat in the organic system is popularly referred. No doubt, to this chemical source exclusively animal heat has been referred with such exactness of calculation as seemingly to leave no room for any other calorific or frigorific agency, and indeed nothing more to be desired. But all such calculations are so made as to be self-correcting as they proceed, their product being also a foregone conclusion. It is therefore not to be wondered that they throw no light on the phenomena of fever or any of those abnormal states of the system as to temperature, between which and the rate of nutrition or of respiration no connection can be discovered.

And here let us bring to a close our inquiry as to the molecular

structures which result from 5Hf when they can secure one atom of H first as a leader and then as a companion. Having hydrogen previously given, we obtain in this case aqueous matter and oxygen. But as has been already hinted, 5Hf may give being to other elements.

SULPHUR.

In constituting an atom of oxygen, the 5Hf (which Hf I have sometimes called hylagen) are united poles to equators and by their facets. But they may also be united poles to equators (that is, by their dissimilar and therefore permanently cohesive parts) by their edges. In this case, from the same material as gives an atom of oxygen, another element is obtained, which may be regarded as an alternate form of that material, and which in its functioning must have singular analogies as well as differences with oxygen. Let us in the meantime designate it by the literal symbol S (see the fig.).

We may also conceive its genesis in connection with our molecule of $(\text{OHaqHO})^{12}$ or reduced water, though that is not the most natural connection. Thus, in this molecule, the 12 surface regions being atoms of oxygen whose poles are empty externally, and in want of an axis, it is to be expected, supposing the molecule to exist in the midst of protoplasm in which atoms of Hf (hylagen) have been already developed, that each atom of O will attract one of Hf into its empty pole to form an axis for it. But every such atom of hylagen thus placed presents four points for the attachment of others which are still unoccupied, three on its equator and one on its outstanding pole. These, therefore, will also tend to be taken possession of by other atoms of hylagen. Thus each of the twelve atoms of O will be a cup or receptacle for five atoms of Hf , three of them standing out like three stamens around the other two, which are in one line and form the axis of the structure like ovary and stigma in the same flower. And thus we might fancifully say, that one molecule of reduced or concreted water has come into flower, and shown that it belongs to the monocotyledonous class of vegetables—a remark which, as has been already hinted, is not altogether fanciful or devoid of scientific value, since, when we compare together the two great classes of flowering plants, it may be truly said that the monocotyledons are those in which the aqueous tissue preponderates as compared with the dicotyledons in which the carbonaceous tissue preponderates. But as in a flower the tips of the stamens, either mediately or immediately, sooner or later, apply themselves to the stigma, so here the 3Hf , at first sup-



posed to be spreading, must sooner or later place their axes parallel to those of the other two, so that their previously free poles fall upon the equator of the upper atom of H in the axis, which when they have once done they must remain united; for there is thus generated at each of the six regions where the five atoms of H are united together a triangle of force, and at the seventh region, namely, the centre of the structure, a coupled triangle of force. Now, such a combination of equal and similar forces is so stable that it cannot be decomposed, or otherwise be destroyed, except by being exploded.

Thus we obtain, in each of the twelve surface atoms of O in our dodecatom, twelve atoms of S , which, once constructed, must be very stable. Now, on comparing S with O , it will be seen that S is defective in equatorial matter, as O was found to be in polar matter. There are, in fact, in the equatorial region of S , three cavities wanting to be filled up, there being around that centre room for six, as in aq. Now, for fill-

ing up, three other atoms of S are very suitable; and if they come on so that a pole of each may gain the centre of the fourth atom of S , which thus becomes an axis to the system of four, the whole structure may be very stable. We thus obtain $S = S^4$. (See fig.)



Sulphur, $S^4 = S$.

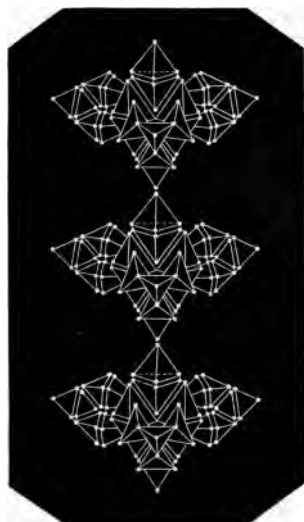
And now, our new element agrees with oxygen in being what may be naturally called a negative form, that is, a form which is defective in axial as compared with its equatorial expansion, and which, when viewed overhead in its æthereal atmosphere, is an oblate spheroid; the prolate spheroid being taken for the positive form.

Atoms of S , therefore (supposing that no very high temperature has imparted so much action to the axis as to improve their sphericity), when admitted to the aeriform state, will not rise singly, nor yet will they rise like atoms of ordinary oxygen in couples, but rather like oxygen as ozone in sets of three, one on each pole of the central atom—which last in such a situation will dilate so as to make the whole structure much more nearly spherical than it is represented in the diagram on the next page.

In this way then, the twelve atoms of S , which we have supposed to encrust one molecule of concreted moisture, may be imagined to escape from it.

As to the weight of this new aeriform ($S^{12} = SSSS$) it must

(if the law of assimilation still insists upon the normal or atmospheric unit volume for it) be six times that of oxygen gas. Thus, while the atomic weights of O and S are the same, namely, that of $5\text{H} = 5 \times 8 = 40$, that of $\text{O} = 2\text{O}$ is $80 = 16$ when $\text{H} = 1$, but that of $\text{S} = 4\text{S}$ is $4 \times 40 = 160 = 32$ when $\text{H} = 1$, whence that of 3S must be $3 \times 32 = 96 = 6 \times 16$, that is, six times that of oxygen gas. But when the pulsatory action or heat of the triple system of atoms of S is so great as to separate them, and each occupies an unit volume, the weight of the aeriform in that case will plainly be twice that of oxygen gas. Here, then, we have all the well-known phenomena, of sulphur vapour as it rises, and when it is risen and very hot.

Sulphur Vapour, $\text{S}^4\text{S}^4\text{S}^4 = \text{S}^3$.

Plainly, however, in SSS the poles are overloaded. The proper element for carrying up an atom of S into the aeriform state is not another atom of S on each pole, but an atom of H on each pole. This gives a very beautiful, but also a very formidable structure, resembling a combination of lance and halbert. That it answers to the chemical formula H_2S when $\text{S} = 32$ is too obvious to require proof. But what a mistake in the popular chemistry to maintain that, because of the resemblance between the formulæ H_2O and H_2S , the substances which these formulæ stand for are similar! On the contrary, are they not as dissimilar as moisture, the most genial and the most necessary of all things to life, is from sulphuretted hydrogen, the most hateful and poisonous.

Sulphuretted Hydrogen, HS^4H .

When there is neither hydrogen nor heat enough to retain atoms of S in the aeriform state, they must form into molecules. And since all the dimensions, both of S and S , are trigonal both as to poles and equator, the molecule must be that which results from trigonal constituents, which, when most perfect, is the icosahedron or icosatom.

And here we find a verification of the conclusion to which the law of assimilation conducts us, namely, that the volumes of molecules when in the dense state, whether liquid or solid, ought to be equal, or in some most simple ratio to one another. This, chemists have long ago found with regard to aeriforms. But having no certain principles to guide them with respect to the molecules of aeriforms when condensed, they have not attempted to calculate their specific gravities, except by creating a doctrine of the atomic volume of the elements in the dense state by the aid of the balance which, after all, loads the subject with exceptions and anomalies.

But a regard to the cosmical law of assimilation enables us to extend the method, known to hold good with regard to aeriforms, to liquids and solids also; and this we may show in the present instance. Thus, taking AQ as the unit volume for dense molecules, since its power as a type of volume, or as an assimilative agent in respect of volume, must be no less in our planet than common vapour azote and oxygen gas for aeriforms, we obtain the following formula for the specific gravity of sulphur:—

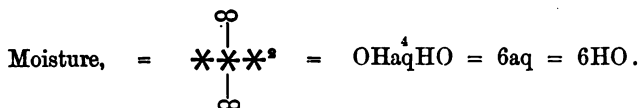
$$\frac{(\S)^{20}}{AQ} = \frac{20 \times 160}{36 \times 45} = 1.96 \text{ Expt. } 1.98.$$

But the icosatom of sulphur may be constructed in either of two ways, giving a small variation in the volume. Our $\S$ must be also capable of a plastic state, interposed between two states of fluidity. It must also possess two forms of crystallisation; for a more ample notice of all which I must refer to previous parts of this work, as also for details respecting the various forms and properties of the fumes of burning sulphur, which in certain conditions of existence readily give up some of the oxygen in them, and in certain other conditions urgently demand more oxygen, being, in fact, represented by either of these formulæ—

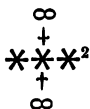


in all of which the ratios of O and S are the same, and, as it happens, the weights of both elements equal (see Part III. p. 34).

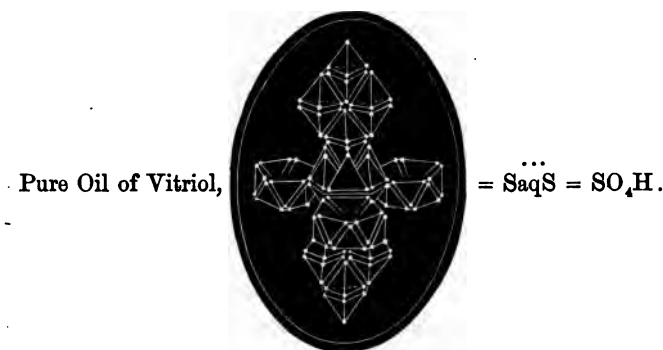
Rather let me here notice the form of repose to which this element attains when aqueous matter is supplied to it. We have seen that the primal aqueous structure which we may call



Now, instead of this, when fumes of S are flying about, we may have the structure still preserved, while S is substituting H, thus giving—



in which the dagger represents one atom of S. Here we have fumes of sulphur in a moist or hydrated state, the poles, however, being over-headed with oxygen. Now let another atom of O be supplied, and then the oxygen will be transferred from the poles to the equator; for the three atoms of S may be symmetrically applied there in the place of the three atoms of aq. In this way a much more stable structure must result than existed before, while yet the original type is still preserved. Now, what have we here? It is what we call sulphic acid, otherwise



We may represent its formula by $\overset{\cdot\cdot\cdot}{\text{SaqS}}$, in which the dots stand for atoms of oxygen. Its usual chemical formulæ are SO_3HO and SH_2O_4 , in the latter $\text{S} = 32$ and $\text{O} = 16$. This latter, however, though at present it is the favourite, gives chemists much trouble in consequence of the ascertained specific gravity of oil of vitriol. According to that formula, and the chemical rule for the specific gravities of compound vapours, its sp. gr. ought to have been the double of what it is actually found to be. It ought to have been $3.2+$, instead of which it is only found to be $1.6+$. Hence it is necessary to admit that the aerial unit of oil of vitriol occupies 4 normal or hydrogen volumes instead of 2, which it is destructive of the present state of chemical hypothesis to admit, except as an anomaly in nature (which is nonsense). From this predicament, however, our view of the structure of the atom of oil of vitriol relieves the afflicted vapour.

But more interesting still is the light which our molecular morphology throws in this case on the specific gravity of oil of vitriol in the dense state. Thus, suppose the boiling of oil of vitriol to have been continued so long that no more water can be expelled, it is still found that $\frac{1}{12}$ th of an atom of water remains for every atom of oil of vitriol. Now let atoms of oil of vitriol gather round an atom of aq as a nucleus, when all the rest of the original aq has been expelled as by boiling, then since there are 12 points in the atom of aq, on each of which an atom

of pure oil of vitriol may fix itself, we shall have for every atom of oil of vitriol just $\frac{1}{12}$ th of an atom of water remaining, a result which has been found in the laboratory, nay, found impossible to prevent—though it is surely very strange, when viewed in the light of the popular chemistry, that it should be so,—but not the less to be cherished, perhaps,—since wonder is one of the chemist's most favourite emotions. As to the sp. gr. of the liquid, which it is more agreeable to us to be able to deduce than to wonder at, its equation stands thus—

$$\text{Strongest Oil of Vitriol } \left\{ \begin{array}{l} \text{attainable by boiling,} \end{array} \right. \frac{(\text{SaqS})^{12} + \text{aq}}{\text{AQ}} = \frac{(12 \times 245) + 45}{36 \times 45} = 1.843 \text{ Expt. 1.843,}$$

which corresponds to a temperature exactly the same as that at which the sp. gr. of sulphuric acid was taken by Professor T. Thomson in Glasgow, that great centre of the manufacture and use of oil of vitriol, that great chemist always reasoning well, though not always weighing so accurately.

A more natural structure is when atoms of oil of vitriol gather round an atom of AQ, which gives 2aq in each atom of oil of vitriol, or when, at any rate, there is an atom of aq for every atom of S. This is known as the glacial acid. Aggregated around the sulphic pole, the molecule has stability sufficient to stand the boiling. As that pole is trigonal, the perfect molecule must, therefore, be the icosatom. Allowing to so large a molecule two aqueous volumes, we obtain as its equation of sp. gravity—

$$\text{Glacial Oil of Vitriol, } \frac{(\text{aqSaqS})^{20}}{2\text{AQ}} = \frac{20(45 + 245)}{2 \times 1620} = 1.79 \text{ Expt. 178,}$$

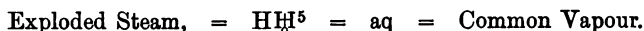
which is again, as we may say, quite exact, since the second decimal depends on the temperature at which the experiment is made.

The molecule of the glacial acid, however, though not in the laboratory, yet in nature maintains the more perfect aquæform, and consists of 36 instead of 20 members, at least when its acidity has been quenched or neutralised by an encrustation all over of lime. This is proved by the sp. gr. of sulphate of lime, gypsum, or selenite (see Part II. p. 95, or Part III. p. 41.)

But let us here pass on, remarking only that, from these discoveries, it appears that the views of chemists are too narrow when they regard hydrogen alone as the acidifying principle. From these discoveries as to the structure of the atom of sulphuric or rather sulphic acid it appears that H₂ as well as H, when it forms a pole, as in the atom of S, or sulph, can acidify. Both are indeed isomorphous, and that they should both be acid-producers favours the idea of the old chemists, that there must be something lance-shaped about an acid since it is lancinating to the tongue, and generally of a piercing and solvent nature.

AMMONIA.

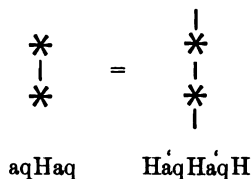
The first differentiation of our protoplasm we have found to be the construction in it of atoms of $\text{H}\dot{\text{H}}$ and H , which enter into union with each other, so that H is saturated with $\text{H}\dot{\text{H}}$, whence, taken in its limits of maximum and minimum expansion, we obtain the equation of—



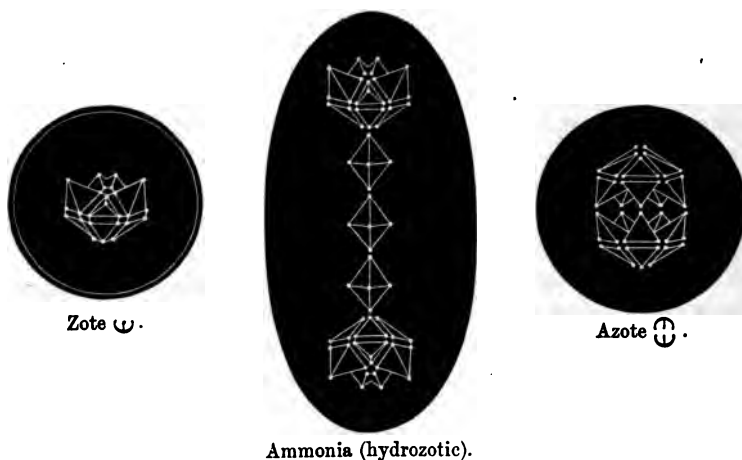
Let us now again recur to an atom of H as a nucleus, and on each of its 5 points for union, instead of an atom of $\text{H}\dot{\text{H}}$ let us place an atom of their united product aq , giving—



This structure resembles that which we found to be the first type in the progressive synthesis of atoms of aq into molecules (fig. p. 147). It differs only in this, that the central body, instead of being an atom of aq , is an atom of H . Consequently there are in the axis, instead of 3 aq , only 2 aq , and these two bolted together, as we may say, by an atom of H , its trigonal or lance-shaped positive poles piercing into and filling up the negative or hollow poles of the atoms of aq above and below. Now, this difference of structure must introduce a great difference of product as to secular results. In fact, the two atoms of aq , thus bolted together by the atom of H , cannot easily separate. The whole must usually continue as one structure. But if so, then if there be any defect of symmetry in its structure, it must secularly undergo improvement in that respect. Its symmetry will be perfected as far as possible. Now, on inspecting the atom of aq , it will be seen that in its centre there are eleven material elements or unit-forces, while six are sufficient and proper for the symmetry of the hexatomic structure. There are five, therefore, which are disposable. The terminal polar regions of the coupled atoms of aq also are empty and negative, while an atom of H in each would fill them in a proper manner. Now 5 units are just the material required to construct an atom of H . They do, in fact, tend naturally to develop into an atom of H . Secularly, therefore, and very soon after aq has been given to nature, aqHaq will be given, and the latter will develop into HaqHaqH , the spiritus asper above the symbols of aq , as given below, implying that each has given out one atom of H —



Now, when the equator of such a structure is loaded and expanded, as for instance, by carrying $3aq$ (which we have supposed) or otherwise, so that the whole structure, viewed overhead in its æthereal atmosphere, is oblate, then under the law of sphericity there must exist in the axis a force calling for the extension of that axis, and in that case the axis may be expected to extend by undergoing a most remarkable transformation. No more now, indeed, can the atoms of aq transform themselves, as before, into HO . Each of the five atoms of $H\dot{I}$ that now go to the aquæform aq has lost one of its material elements or forces in the centre. Each now consists of seven instead of eight elements, and is intensely unsymmetrical in the structure of its equator. The $5H\dot{I}$ in aq must therefore remain united as they are, to supply each other's defect of symmetry. They cannot open and turn round as they might do, in order to construct an atom of O . They must keep together at the centre as they are. And when, by the lengthening of the axis, the atom of H is taken from the circle of 6 and placed in the axis, the five defective atoms of $H\dot{I}$, when duly compacted, must give a hemiform such as $\Im$, and $aqHaq$ will now give $\Im H^3\epsilon$.



Meantime, the atom of H in each of the poles of $HaqHaqH$ will be given off during the transformation; for the poles of $\Im$ are 5-partite in structure and no longer conformable to the trigonal shape of H .

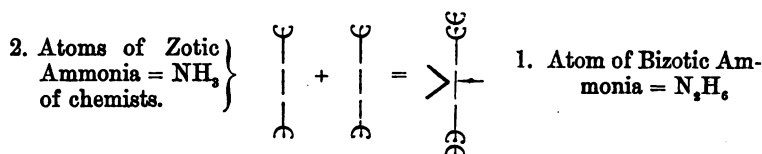
And, suppose the structure $\Im H^3\epsilon$ to be decomposed as by an electric shock or otherwise, plainly the two dissymmetrical hemiforms will under the law of symmetry and sphericity couple, for by so doing they may generate an eminently spherical and symmetrical element (see fig.). Now, since this coupled element possesses such a perfect form, it must be very reposing in nature, or, as the chemist says, inactive. And its

atomic weight must be $2 \times 5 \times 7 = 70$, *i.e.*, 14 when $H = 1$. It therefore represents azote. And the dimorphous structure which we have obtained, when decomposed, must yield three volumes of hydrogen and one of azote. It therefore represents ammonia. In its primal form it is isamorphous with a couple of atoms of common vapour united on the same axis, and must, therefore, in its functions, have many analogies with common vapour. Its activities and powers, however, must be much greater. In fact, they are wonderfully many. Common vapour, and the aqueous element in general, is quick, but ammoniacal vapour is far quicker and of double force. Both are plainly most suitable for entering into the construction of tissues which are to possess quickness or animation, but ammonia still more than aqueous matter.



Ammonia (aqueous form).

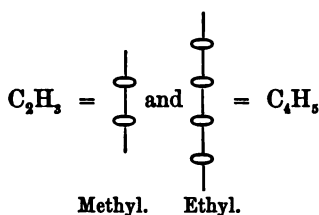
But ammonia may lose its quickness and become stable by doubling, and this is the state to which the chemist most frequently reduces it in the laboratory. Thus, making use of the pharmaceutical symbol to stand for half azote (which, from its extreme activity attaching to its hemiform and want of symmetry, we have called zote), we shall have, when all lateral or equatorial support has been taken away—



The latter is no longer capable of lapsing into the aquæform. It may also be stable to a considerable degree, for though its body be still volatile hydrogen, yet that hydrogen exists in normal typical molecules, each being HH^5 homologous with HH^5 and Haq^5 , and, indeed, a repetition of the form of the single atom of H, though with five joints or articulations. In fact, HH_5 or HH^5H is the typical aeriform molecule of this, the lightest of the elements.

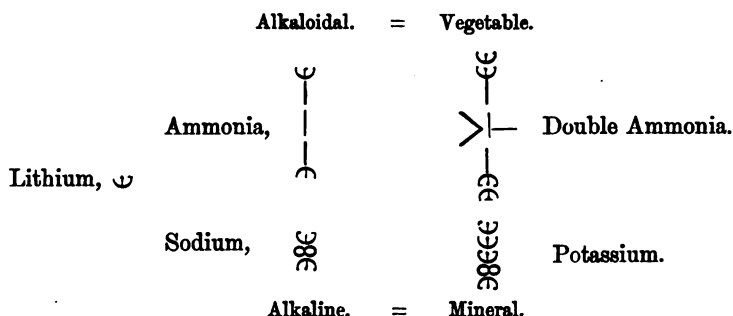
Here we may remark, in passing, the extent to which chemists have amused themselves in substituting for the simple hydrogens which are in natural ammonia, other hydrogens which are less mobile and volatile, inasmuch as carbon or some other fixed element enters into their structure, while yet both their equators and poles continue to be atoms of hydrogen, so that they may function like single atoms of hydrogen. Adopting in the meantime a cypher as the printers' type, to stand for an atom of carbon, its atomic weight taken at 6 when $H = 1$, as it

used to be universally (and for good reasons, as will appear). Such hydro-carbons are (alcohol radicals !)



&c., their insulable forms being usually their doubles with carbon poles.

When the true ammoniacal structure is thus steadied by C_2H_5 or C_4H_9 , &c., instead of H_2 or H_4 (thereby destroyed for all the uses of life), and oxygen is made to enter into the structure, chemists are surprised to observe how similarly to potass and the fixed alkalis the products function. But the truth is, that in these structures of the laboratory, inasmuch as the volatility of pure hydrogen in ammonia is overcome by the addition or substitution of more stable elements, there is an approach to the construction of the fixed alkalis. The latter we obtain, when for the 3H or 6H in the atom of single or double ammonia, oxygen is substituted as the coupling joint for the single or doubled atoms of zote which constitute the polar bodies. It is true, that in this case the zotic element has usually quite a different genesis from that which results from the transformation of ammonia, and more generally possesses the full atomic weight of $5\text{H} = 40 = 8$ when $\text{H} = 1$ instead of 7. Still its reduction has been fully accounted for (Part III. p. 52); and when thus reduced, it has been shown to explain all the properties of lithium. Thus, contenting ourselves with the types instead of diagrams, we have—



Their molecules are all the usually differentiated dodecatom, so that their sp. gr. may be deduced, allowing $\frac{1}{2}$, 1, and 2 normal volumes as they increase in complication—thus

Lithium, G . . .	$\frac{(L)^{1+12+1}}{\frac{1}{2}AQ}$	=	·60 Exp. ·59.
Sodium, G . . .	$\frac{(Na)^{1+12+1}}{AQ}$	=	·99 Exp. ·97.
Potassium, G . . .	$\frac{(K)^{1+12+1}}{2AQ}$	=	·84 Exp. ·86.
Ammonia, G . . .	$\frac{(Am)^{1+12+1}}{AQ \text{ or } 2AQ}$	=	·73 Exp. ·74.

CARBON.

But what of carbon, whose atomic weight, contrary to the present fashion I am giving, as 6 when $H = 1$, while it is now usually given at 12, and that for reasons which, if applied to our vision generally, would prove (since the functioning of both eyes is single), if only our eyes were so small as to be invisible, that we were all monoculi.

As to carbon, then, it may be remarked that, wherever zote has been constructed, another element is imminent. Let the 5 units which render one polar region of the atom of zote, 5-partite and dissimilar to the other polar region, be constructed into an atom of H, as they must secularly tend to be, and then instead of the original $5H$, we obtain a beautiful cellular structure of exquisite symmetry and stability, carrying an atom of H on its pole. Like O and ω , it is oblate, however, and therefore when free its atoms will tend to go in couples also.



CH.

Carbon ∞

Its atomic weight is $5H - 2H = (5 \times 8) - 2 \times 5 = 30$, i.e., 6 when $H = 1$, and that of the coupled atom corresponding to the unit of oxygen-gas or azote is 12. In a word, in every feature this highly reduced element represents carbon.

Its characteristic is that, in order to reach it, two atoms of hydrogen must be developed out of the matter, viz. $5H$, which furnishes it, so that, previous to loss, it must appear in nature in union with two atoms of hydrogen, one on each pole (see fig. HCH, next page).

But such a form is very prolate, while two by coupling reproduce the primal type of an atom of H as nucleus, with 5 other atoms around

it, in this case 3 atoms of H for the 3 points for union on the equator



Nascent Marsh-gas, HCH.



Marsh-gas, $\text{CH}_4 = \text{C}_2 \text{H}_4$.

of the nuclear atom, and one of carbon on each of its poles (see fig. CHC). And, in reference to such a molecular structure, whether we look to sphericity, cellularity, or adequate differentiation, we see that it is very perfect. Now to us it plainly represents marsh-gas; and therefore prepares us for finding that substance so generally diffused, and such a survivor in nature as it actually is.

Do not the conditions of its genesis also explain why carbon should be the very substance that it is, so averse to, and even incapable of, the aeriform state? Thus every atom, when its genesis is complete, *i.e.*, as HCH is furnished with two atoms of hydrogen, which we may regard as two wings. And when they have been cut off or carried away, is it wonderful that the bare atom of carbon remaining should be as incapable of flight as it is found to be?

At any rate, it appears that it is to this, its aversion to the aeriform state, and its determination to reintegrate its original union with hydrogen, that carbon owes its peculiar value in the economy both of animal and vegetable nature. Meantime its value as a fixed element is great.

Thus we have seen that both the aqueous and the ammoniacal elements, which are the first products of the differentiation of our pure or homogeneous protoplasm, are both of them very quick to go off in vapour, or, if remaining, are ready to be transformed into still more aeriform elements, namely, into hydrogen, oxygen, and azote. Life in an organism, therefore, if that organism were constructed only of them, could not but be altogether ephemeral. Plainly, there is wanted some other kind of element which in its nature is fixed, or such that it shall not tend to go off as an aeriform—not altogether fixed, for that would imply a state of death, but fixed in a degree so as to moderate more or less the tendency of the others to go off into the aeriform state. Now for such a function carbon is altogether suited. Every atom of it may indeed be

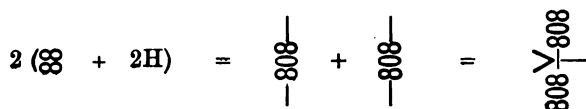
regarded as a bolt, sure as adamant, which indeed it is. Keep away oxygen or hydrogen and it will remain fixed and a fixer long enough. But let oxygen gas come in the way, every atom of which is precisely adapted for nipping up an atom of carbon and carrying it off as an aeriform, and off goes the carbon. Thus, when two atoms of oxygen exist, coupled on the same axis, thus constituting an unit of oxygen gas, there is, in consequence of the concavity of both the interior poles, a hollow in the centre, or an empty stomach. Now this hollow is precisely a mould for an atom of carbon! Hence an atom of oxygen gas (which is everywhere prevalent in the terraqueous globe), when it enters an organism in the active, empty, hungry state, and meets with an atom of free carbon, forthwith devours it, and though to all outward appearance still only an atom of oxygen gas, isomorphous and isovoluminous, and able to escape by the same channels, or channels no larger than those by which it entered the organism, it carries off the carbon. But though isovoluminous with the pure oxygen, it is now all the heavier by the atom of carbon which fills the stomach of each aeriform element. It is also, as might be expected, less elastic and less diffusive. Hence it tends to prevail in the lower strata of the atmosphere, where there exists the vegetable kingdom. And for this kingdom it supplies the requisite food!



Carbonic Acid, $\infty = \text{CO}_2$.

And here the deeply interesting question in physiology occurs, How comes it to pass that, while in the most highly animated organisms, those of animals, namely, oxygen gas lays hold of carbon and bears it away in such firm union that even the chemist can scarcely decompose it; yet in stable and cool organisms, those of plants, this carbonic gas is readily decomposed, the oxygen gas escaping pure and free again, while the carbon is retained to perform the same function in vegetable nature (that of imparting durability to the tissue) which it had previously performed in animals? To this the answer, I believe, is, that inasmuch as the primal union of carbon, even the union implied in its genesis, was with hydrodgen, not oxygen, so, under the law of assimilation, acting in reference to time, that is, as a law of heredity or redintegration, the hydrogen nascent in the vegetable tissue succeeds in expelling the oxygen from the carbonic gas which is brought in, appropriating the carbon, and setting the oxygen free. If it be alleged that such a view is a substitution of magic for science, the answer is, that that is just as one takes it. The operation of all law may be said to be magic till the mechanism is discovered by which the law is realised or worked out. Moreover, here we are not without an appre-

hension of the mechanism. Thus there is nothing better established in molecular science than that it is dissimilars which tend to unite, while similars tend to repel each other. Now, by similars in our molecular morphology we must, in the first place, mean similar forms—forms which, viewed overhead in their aetherial atmospheres, are either both or all oblate, both or all prolate, both or all spherical. Thus an atom of oxygen viewed overhead is oblate, so is a tetratom of hydrogen, (see the diagram below, and that of marsh-gas, fig. CHC , p. 164). Let us suppose, then, that two atoms of carbonic acid gas, CO_2 , have entered into the vegetable tissue where chlorophyll is normally functioning. Then, in order to their being wholly reintegrated, it is necessary that an atom of H be supplied to each of the two poles of both, for this is necessary to reintegrate the primæval 2 aq, from which we suppose everything organic to have been derived. But when the poles are thus supplied, the two are ready for doubling into one—



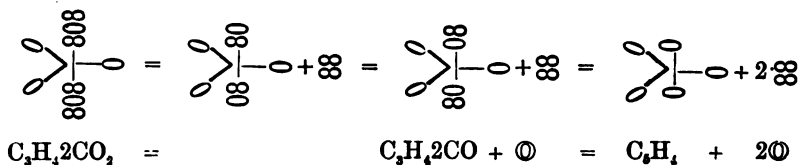
There is thus constructed as the equatorial body in the unified structure a tetratom of hydrogen, which is very oblate.



Tetratom of Hydrogen.

But in maturely elaborated parts of plants, in chlorophyll, for instance, there is so much carbon, compared with hydrogen, that we cannot suppose that the outstanding poles of the three atoms of hydrogen in the equator of $\text{C}_3\text{H}_4\text{O}_4$ would long remain naked. Doubtless each of them, if not from the first, would soon be capped by an atom of carbon, and become an atom of

hydro-carbon, CH. Now, by such an addition the equator would be still further extended, and thus the whole form rendered still more oblate. But if so, it will be rendered still more highly repulsive of the oblate oxygens on the poles. We may, therefore, when the structure is rendered active, as by the sunbeam playing upon it, expect a process of dissociation and reduction, which may be thus conceived—



Thus we obtain, as the product of the solar action, pure oxygen gas and a hydro-carbon. Now, let us see what this hydro-carbon represents. Its elemental formula is C_6H_4 . But it is obvious that it is highly polymorphous, for the three atoms of carbon may apply themselves to the three equatorial hydrogens and to the axis in a great variety of ways. If, then, this hydro-carbon represent anything in vegetable nature, we may expect a considerable number and variety of hydro-carbons with the same chemical formula. But will the single element C_6H_4 be insulable by itself? No, its form is so oblate that, like so many other molecules that we have met with when in the aeriform or most fully individualised state, they will still go in couples on the same axis, each represented by the formula $C_{10}H_8$. Now, this is the half-formula of what is usually given as that of the non-oxygenated essential oils. Its sp. gr., as compared with air, must be—

$$\text{The Vapour, } G = \frac{C_{10}H_8}{\frac{1}{2}(4Az + \odot)} = \frac{300 + 40}{\frac{1}{2}(360)} = 4.7 - \text{Expt. 4.7. Essential Oils.}$$

As to its condensed state, since its trigonal equator extends so far beyond its poles, its molecules must be those of the trigonal series, that is, the tetratom or the octatom, and ultimately the icosatom, as the culmination molecule. Now, constructing these possible molecules, and allowing half a normal volume to the tetratom, one normal volume to the octatom, and two to the icosatom, we obtain, just as in the distillation of the essential oils, a lighter and less perfect (and consequently a more volatile and fragrant oil), and a heavier and more perfect (and consequently less valuable perfume), the specific gravities of both, as determined by the balance, being the same as those which our formula gives—

$$\text{Light Essential Oil, } G = \frac{(C_6H_4)^4}{\frac{1}{2}AQ} = \frac{4(150 + 20)}{\frac{1}{2} \times 1620} = .84 \quad \text{Expt. .85.}$$

$$\text{Heavy Essential Oil, } G = \frac{(C_6H_4)^{20}}{2AQ} = \frac{20(150 + 20)}{2 \times 1620} = 1.05 \quad \text{Expt. 1.04.}$$

The economy of nature then, in relation to oxygen and carbon, so far as we have touched upon it, is this, that, by their respective forms which imply their eager union wherever oxygen can penetrate among atoms of carbon existing single and free or loosely engaged, they unite all through the animal organism, which is everywhere penetrated by oxygen, and everywhere disengaging carbon in single atoms. By this means the effete carbon in the animal organism, which is tending to a chaotic and wholly obstructive state, is constructed along with the oxygen now taken in union with it into carbonic dioxide, commonly, but not correctly, called carbonic acid,* a most serviceable heat being generated.

* On Carbonic Acid, properly so called. see P. III. p. 92.

Thereafter, the true carbonic acid formed, when it has served important purposes in the organism, breaks up into carbonic acid gas, which escapes into the air by the lungs, the skin, &c. Thus, the organism is relieved of matter which must otherwise soon have proved fatal to its action, and have caused death. But having thus gained the atmosphere and the sunshine, this deadly gas brought by its own weight into contact with the ground and its vegetable covering is decomposed there, its oxygen being restored in purity to the atmosphere, to serve for breath and life again to the animal kingdom, while its carbon goes to supply just the food which is needed by the vegetable kingdom in order to the construction of its timber, which is so necessary in the processes of human art, as also to the birth of those perfumes by which that kingdom in its most sunny and highly matured parts is rendered so deliciously fragrant.

Thus, in pursuing the differentiation of our primal homogeneous protoplasm, we have obtained, first, aqueous matter, as common vapour; and, secondly, from it, by doubling and reduction, ammoniacal vapour. Then, by the decomposition of aqueous matter, we obtained hydrogen and oxygen, while to the same epoch of nature the appearance of sulphur belongs, and soon after the fixed alkalis and silica, of which, however, nothing has been said here.

AZOTE.

By the decomposition of ammonia we have obtained, instead of oxygen, another still more active element—an element so active as to be like fluorine, still unknown to the chemist in a separate state. This we have called zote. And as oxygens by coupling give oxygen gas, which is much less active than oxygen in single atoms, so do zotes by coupling give azotic gas, the other great constituent of the atmosphere, which is very inactive. (See fig. p. 160.)

Where atoms of zote cannot couple we have seen that, owing to their dissymmetry, they must suffer reduction. And in this way there is given to nature carbon in union with hydrogen. (See fig. p. 163).

SILICON.

Let us now remark, that the atoms of zote, when so coupled as to constitute an atom of azote, that is, when united so that the summets of their 5-fid poles merely touch each other, may also give to nature another element, which plays an important part in the simplest organisms as well as in the crust of the earth generally. Thus, instead of merely touching each other by their tips, let these 5-fid or 5-toothed regions of the two atoms of zote in one of azote be locked together by pressure or



Si.

otherwise, and in this case there must result an exquisitely spherical molecule with the same atomic weight as azote, and still more inactive or reposing. I have elsewhere shown in detail, and it may be easily seen that such a structure represents silicon.

CALCIUM.

But what of lime? Where it, may be asked, in our process of differentiation, does calcium make its appearance—calcium which plays such any important part both in the organic and the inorganic world?

To this it may be answered that given free hydrogen existing in quantities under cold or pressure or both, or on the pole of a molecule, such as sulphuretted hydrogen (see fig. H_2S , p. 155), our calcium may possibly be generated. Thus, let atoms of H_2S form into molecules, then in virtue of their trigonal dimensions, these molecules must be icosatons. Each nucleus will thus be a structure consisting of 20 atoms of hydrogen wedging each other together. And this they may do secularly so closely that the interceding æther of their atmospheres may be in the main extruded, and thus the group of 20H be consolidated so as thereafter to be undecomposable in the laboratory. Its form and structure are eminently fine. Its atomic weight is plainly $20 \times 5 = 100$, *i.e.* 20 when $H = 1$. It may be shown to represent the atom of calcium when it has attained its utmost perfection of structure, or what may be called organic calcium. Calcium, however, must also result from the dedoubling of an atom of unreduced potassium as has been explained elsewhere (Part III. p. 48).



SILICIUM.

It has also been elsewhere shown that this calcium H^{20} , though it possess such an exquisite structure, yet being wholly undifferentiated cannot be altogether stable and permanent for ever in nature. It has been shown that the 20 material units in its centre must secularly repel each other until they take the place of those on the surface, which will meantime go off in groups of 5 as atoms of hydrogen, while also the 5 on the poles will gather themselves up into hydrogens. And thus, there will result a structure similar to that of nascent marsh-gas (see fig. SiH_4 , next page), but with this difference, that the central molecule in this case has an atomic weight of 70, *i.e.* 14 when $H = 1$, and represents with great perfection all that is known or conceived of silicium.

This, the prevalent constituent of our planet, then, according to our molecular morphology, exists in two states—a less mature state, containing still 10 units in its centre, wholly metalloidal, which the term

silicon very well expresses, and one which is truly cellular, and as has been shown elsewhere, might be called semi-metallic, being an element of a brittle metal, and which the name silicium equally well expresses.

Hence, a consequence of our theory of matter, to the effect that calcium, in the lapse of the ages, must be gradually transformed into silicium with emission of hydrogen (which will give a second crop of calcium, and, along with oxygen, aqueous matter, &c.).

But where oxygen gas abounds, as it does everywhere in the terraqueous globe, of course it is not hydrides, such as CH_4 and SiH_4 , that we are to expect in nature. An atom of $\odot$ will attack each pole, and there will result $\text{CO}_2 + 2\text{aq}$ and $\text{SiO}_2 + 2\text{aq}$.



SiH_4



Silicic Acid, SiO_2

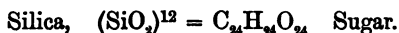
Since the poles of silica are pentagonal, its molecule must be the dodecatom, which may, of course, be either differentiated as usual or not. Both molecules occur in nature. But since coupled atoms of silica in the first instance, giving an atom of $\odot$ in the centre and an atom of O on each pole, possess a structure so much more perfect than the single atom, it seems likely that natural molecules of quartz will thus consist of coupled molecules. This gives—

$$\text{Quartz of Fusion, } G = \frac{(\text{OSi}\odot\text{SiO})^{12}}{\text{AQ}} = \frac{12 \times 300}{1620} = 2.2 \text{ Exp. } 2.2.$$

$$\text{Crystallised Quartz, } G = \frac{(\text{OSi}\odot\text{SiO})^{1+12+1}}{\text{AQ}} = \frac{14 \times 300}{1620} = 2.59 \text{ Exp. } 2.6.$$

Let it not be inferred from this that, along with all previous life, all traces of it even, are in the course of being obliterated, and merely silicates and silica destined to increase in quantity for ever. They possibly may do so to a vast extent. But let the ten units now on the outside of the equator of the atom of silica take the course of the poles, and be gathered up, as they must be, into an atom of hydrogen on each,

while the ten triangles of forces thus left naked in the equatorial region take a similar course, joining these summits in the axis of the structure, then the atom of silica is by these axial movements transformed into two structures, each consisting of carbon, oxygen, and hydrogen. And a dodecatom of silica gives the following most remarkable result:—



So that out of the most fixed or dead form by a simple normal movement of material elements, the most vernal product of life may possibly arise!

PHOSPHORUS.

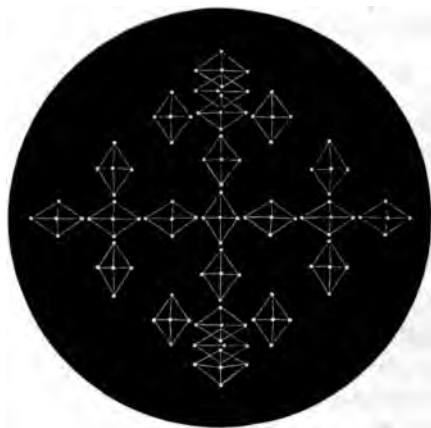
From HH^5 by the course of nature, as we conceive it, we have obtained aqueous matter, oxygen, sulphur, and ultimately lime.

From Haq^5 , by the same course, we have obtained ammonia giving similarly azote and carbon and other elements.

But HH^5 may give rise to molecular structures as well as HH^5 . And since both are isomorphous, we should expect from HH^5 a similar series, especially a light oxygen, a light sulphur, and a light carbon. But except the last named, which represents boron (considered as monotomic), it is no wonder that the existence of the others has not been verified by the terraqueous chemist. Our planet is too small and its synthetising forces are too weak to make much of such a light and volatile subject as hydrogen, when it is not kept down by such elements as are more weighty than ours, or a more intensely gravitating sphere. Nevertheless, we have seen HH^5 forming the body of the atom of double ammonia, and we have characterised it as the typical aeriform molecule of hydrogen, that in which the form of the single atom is reproduced on a large scale. And if now we construct a large aeriform molecule by five of these hexatomic hydrogens placed around, so as to saturate a single atom of hydrogen as a nucleus, it appears that, after the complete condensation of the atoms of light oxygen and light carbon (boron), developed during the process of secular transformation, there results a structure, which has been discovered by science, very generally diffused, though in small quantities, over the crust of our globe, and which has justly excited the greatest interest of the chemist and the physiologist.

The structure $\text{H}(\text{HH}_5)^5$, of which a diagram is given in part, so as not to confuse the eye (see next page), has for its atomic weight $5 + 5 (5 \times 6) = 155$, that is 31 when $\text{H} = 1$. Now, this is the singular but well-known atomic weight of an atom of phosphorus. For a convincing development of this element, I must refer to Part III. p. 105, where it is given in company with its isomorphs, vanadium, arsenic, antimony, and bismuth. I will only remark here, that in phosphorus molecular synthesis comes to a crisis. It may be viewed as constructed

wholly out of hydrogen and boron. But reasons may be given why, under any force adequate to decompose an atom, it could not be resolved into these elements again. It looks rather as if, along with every atom



of hydrogen given (except, perhaps, those which would be developed out of the axis), there would also be given off matter in single units. Now, these single units, springing off into the medium of light, might be expected to impart to the residuary substance an eminent degree of luminosity or phosphorescence, unless this dissipation were prevented, and the genesis of hydrogen again secured by the catalytic action of hydrogen introduced into its ambient atmosphere. In a word, this structure bids fair to represent and explain all the specific characters of phosphorus. But having shown this with considerable detail already in the third part of this work, it need not be repeated here.

I may here remark, however, that the current belief that phosphorus contributes in a special manner to mental functioning, is based on no better evidence than that it is found in greater quantity in the brain than in any other of the soft parts. Perhaps it were nearer the truth to regard its presence there as an evidence of failure so far, in the intense analytico-synthetic action of that organ whose special function is to give birth to something lighter and more luminous still, and out of the sphere of the material altogether.

But phosphorus is intensely useful in nature, both from its dissimilarity equally to hydrogen and oxygen, and consequently its relative activity and the stability of its combination with oxygen when once constructed.

CHAPTER XVI.

ON THE ULTIMATE PRODUCTS OF ÆTHERIAL, MATERIAL, AND MOLECULAR ACTION.

IN the Sketch of a Philosophy which these words now bring to a close, the economy of creation is not regarded as a theory of development all in one direction, as is commonly supposed, but as a cycle in which after development and as its fruit, the last term gives again the first.

Æther and matter after developing a molecular economy become the mother and nurse of beings, which enter into the world of spirits, and present themselves to the great Creator; nay, enter into communion with Him, so far as the finite can comprehend and unite with the Infinite, and partake of His everblessedness.

In the beginning is the Author of all. And as His most immediate creation there is the world of spirits, in the realm of light or the æther, which is their home, the expression in space of the cosmical law of assimilation to the Divine, creation in the æther aiming at His immensity and omnipresence. Thus in the cosmical law there is instituted a tendency to ultimate dissociation or analysis.

But under the same cosmical law, in virtue of the unity of the Creator, which is His indefeasible attribute no less than His immensity or omnipresence, there is awoke also in the realm of light, or the ætherial medium, a contrary tendency in the ætherial elements to association into groups or nebulous specks, in the centre of each of which, when it has attained a certain force, confluence of a definite number of ætherial elements takes place, constituting an atom of a different order from the ætherial element, and which, as the nucleus of its accompanying ætherial atmosphere, gives to nature the material element.

Under the same law and synthetic mode of action the material elements continue to aggregate into thousands of molecules (the far greater number of which are decomposable by chemists, though about sixty-three resist); and these molecules hold on aggregating still until they constitute organisms, whose mobility and easy decomposibility

show that the analytic agency of nature is greatly modifying the synthetic, and gaining upon it in our planet.

In terraqueous organisms these contrasted but co-ordinated agencies culminate, the synthetic in muscularity, the analytic in cerebration.

A cerebral unit, viewed physically, is an organic aggregate, consisting of the lightest elements, held together in a very open structure; and, viewed physiologically, it may be regarded as an individualised volume of æther, more or less spherical, supported by a scaffolding of matter. It is therefore analogous to the nebulous speck in the celestial spaces to which, according to our philosophy, the material element owes its genesis out of the ætherial.

Here, then, we find the material economy assimilating itself in its close to the structure and mode of action which it had in its rise, as the cosmical law leads us to expect. At first it gives to creation in open space a small nebulous speck of æther (without any scaffolding), obliged by the unifying or synthetic action to give birth in its centre, by the simultaneous confluence of the ætherial elements there, to an atom, which is merely geometrical and dynamical, and which in the powers it possesses answers to the material element. At last it gives to creation, in the centre of the organism in which the material or molecular structure and action culminate, a large organised volume of æther (supported by an exquisite material or cerebral scaffolding), obliged by the more powerful unifying or synthetic action proper to it to effect the successive confluence of the ætherial elements in its centre or focus; so that, while the nebulous speck at the first commencement of ætherial synthesis can give to nature no more than a monad still blind and apathetic, and capable of self-preservation and sociality only in the forms of inertia and elasticity with attraction—that is, no more than a material element—this ætherial organism, on the other hand, due to cerebration and accompanying muscularity, gives in its focus of action a monad of vastly greater energy, a monad in which the mental powers proper to the primal substance of creation (after its attenuation in the ætherial element which reduced them to an aura merely), are recovered. Instead of mere inertia there is here conscious self-assertion; instead of blind attraction there is conscious desire, &c. There is, in short, as the proper offspring of this, the highest product of the material economy in our planet, the genesis of psychical beings, ultimately as in man, a soul or spirit, whose mother, nurse, and educator is thus the material organism and the terraqueous world.

Here, then, is the link by which the law of continuity is maintained throughout, and the cycle of things is made to be complete—the link which is missing in the popular science of the day, with this very serious consequence, that, to keep the break out of sight, the entire doctrine of spirit and the spiritual world is ignored or denied altogether.

As to the powers and dispositions which the individual mind will manifest, they must, of course, according to our philosophy, be co-ordinate with the individual peculiarities of the myo-cerebral organism in that individual; and their actual manifestation from childhood to old age, and from hour to hour, must be co-ordinate with the actual functioning of the cerebral apparatus at the time. According as that functioning is normal or aberrant in the individual, so must his mental manifestations be. This responsiveness of the mind to the brain is secured on a two-fold basis. First, there is the situation of the energy of the mind as centralised in the central region of the myo-cerebral apparatus, which under the cosmical law secures the assimilation of the thoughts and feelings as far as is possible to the existing mode of action in the myo-cerebral organism. And secondly, there is the relation on the part of the organism to the mind as mother and nurse, which under the same cosmical law secures assimilation again. Thus the mind is held by the brain, as it were, in double harness. But this is not an evil; for the mind can act and react from within itself with sufficient force; and but for the regulative action of the organism, which is to the mind the plenipotentiary from the kingdom of nature, imparting sensations and affections, and that higher regulation which comes from the imminence of the Deity, constituting reason and conscience, the mind would only curvet and kick and break loose altogether. Nothing less than all the bindings and brain-traces which actually exist would ever reconcile so quick a thing as the mind to drag on this mortal life and carry along with it to the end of the journey this inert heavy body. Nay, though the light of reason shone into it, still, if this were all, and it were a stranger to the pains of hunger and thirst, and the pleasures of eating and drinking, the highest order of minds would be the most neglectful of the necessities of the organism, and the first to be lost to the world. It is therefore no argument against the survival of the mind when dissolution overtakes the organism, that the manifestations of the mind are modified by the organism to the extent that they actually are; for nothing less would render possible such a mixed life as ours.

As to the special functions of the encephalon, both as a whole and as to its several parts, and the lesser systems which are compacted in the organism along with the central system, it is greatly to be regretted that historical anatomy has imposed such a multitude of names and even methods of inspection which are worse than useless. Unsuitable experiments also, even in the present day, have been followed by very unwarrantable interpretations. Nor is it to be expected, so long as the most tenuous and central regions of the cerebral apparatus are looked upon as of no account (though the important name of ventricles has

been bestowed upon them), that much progress will be made in cerebral psychology, or the discovery of the residence in normal states of being of the centre of action of that mental force or substance which is supreme in man, and which, when all is right, holds in co-ordination with itself, and in subordination to itself, all the merely psychical centres that exist in the organism.

If there really be anatomical evidence for regarding the region of the corpora striata as that from which efferent action or muscularity issues, and the region of the optic thalami as that of afferent or sensation-awaking action, then according to this view the hemispheres would be a development co-ordinated with these two regions, a store of energy, a vault or concave reflector, having its focus of central ætherial pulsation, there where, consequently, there would be the birth and growth of the centre of energy of that being in which the access of motion generates feeling, and in which, reciprocally, feeling generates motion.

Being a true unity, and belonging as it does to the spirit-world already, it will escape at death from the little world of æther within, which has been its mother and nurse, into the great world of æther without, the realm of light, which is ambient to every deathbed.

To follow it into that realm belongs to theology. But even there theology can no more dispense with the revelations of science than science here can dispense with the revelations of theology. All truth is at once confluent and radiant in every direction. Thought in its spontaneity has the run of the universe; and there should be no bar to discovery, but sustained experiment that it cannot be made. No method adequate for all possible discoveries can be formulated in words. There is such a thing as inspiration, not for the poet only, but for the philosopher and the man of science also. Not method, but "happy thought," makes discovery. It was a happy thought in Newton that gave to science the idea of universal gravitation. The method now so much in favour—homage to observation alone—so often, as in that case, inaccurate, nearly cost the world that great discovery no one can tell for how long. Method is valuable chiefly, if not wholly, for preventing and for putting thought in order. Discovery is usually due to the spontaneity of thought discharging itself as a member, and to a certain extent as a mirror of the universe.

As to reality, the only adequate evidence or warrant for philosophic belief is the perfect harmony of all things believed, the support that all give to each.

INDEX.

	PAGE
Adoration, its scientific value,	1
Abiogenesis or Biogenesis?	6
Æther universal, its origin,	63
Alimentation, necessitated by respiration, &c.,	83
Alkalis, their structure and relations,	162
Amœba, its contribution to the earth's crust,	13
—— encysted, similarity to human ovum,	22
Ammonia, its genesis and structure,	157
Analysis and synthesis, their organic relations,	43
Animals, provision for their abundance,	88
—— a most general view of,	87
Antherozoids, their origin,	24, 73
Animal substance, simpler than vegetable,	84
Annulosa preluded,	134
Assimilation, the law of,	41
—— of food,	52
Aqueous matter, its genesis and structure,	142
Attraction, its nature and cause,	44
Azote,	160
Body, a cloud in the azure of spirit,	81
Bones, the typical number in limbs, &c.,	31
Calyx, its place in the flower,	122
Calcium, its genesis,	169
Carbon, its relation to lithium and azote,	163
Carbonic dioxide, how decomposed in the leaf,	100
Carnivora, their existence vindicated,	84
—— their disappearance anticipated,	86
Cerebration, its function and place in nature,	174
Chemical action, its cause and aim,	47

	PAGE
Cilia, their nature and origin,	23, 130
Corolla, its place in the flower,	122
Coral polypes, their contribution to the earth's crust,	17
Creation, a reasonable view of nature,	39
Crust of the earth, its normal origin,	26
Cycle, and not merely development, the system of nature,	173
Development theory, defective,	37
—— conditions of its completeness,	38
Death, its nature and conditions,	89
Differentiation, its origin and necessity,	53
Dodecahedron as dodecatom, its prevalence in nature,	67
Elasticity the inertia of form, its origin,	45
Electrical action, its condition and results,	47
—— spider, illustrates elemental respiration,	71
Essential oils, their structure and genesis,	166
Fecundity, precluded by the material element itself,	93
Fingers and toes, their normal number and its cause,	31, 130
Flower, its typical structure and its theory,	121
Foliage, its nature,	125
Food, theory of its necessity,	83
Foraminifera, their contributions to the earth's crust.	17
Forms, the type of	23
Genera, their cause,	42
Geometry, its conditions inexorable,	81
Gravitation, its law and nature,	69
Growth and development, its theory,	83
Heredity, its universality and origin,	45
Homology universal, the secret of nature,	66
Hylagen, what,	140
Hydrogen, its genesis and structure,	140
—— sulphuretted,	155
Hydro-carbon,	164
Inertia, its nature and origin,	44
Immortality, its scientific evidence,	175
Impregnation, its necessity and the reason of it,	73
Imagining, what is it,	43
Judging, its nature,	43
Lasso-cells, their nature and origin,	24
Law of nature, a rhetorical not a scientific conception,	8
Law cosmical, the only law,	42
Leibnitz, the doctrine of the conservation of energy his,	82

INDEX.

179

	PAGE
Liberty, secured in consciousness,	60
Light, the realm of, its place in nature,	64
Life, originally paramount,	10
Life, gives death and needs it,	25
Limbs, their number and cause,	31, 130
Lung and leaf, the friendly struggle between,	86
Matter, its genesis and structure,	65
—— its normal mode of action,	71
Medusidæ, theory of their locomotion,	28
Medusoids,	74
Miracle, not an unscientific conception,	7
Monera, &c., their existence anterior to plant life,	19, 84
Mind, that which can manifest itself to itself,	59
Morphology, its principles universally the same,	105
Muscle, the highest molecular organism,	174
Nebular speck, its structure and issue,	67
Observation, is in reality interpretation,	128
Oxygen, its genesis and structure,	147
Perception, its nature and origin,	43
Phosphorus, its genesis and structure,	171
Polypes,	74
Prayer for physical changes, not unreasonable,	7
Properties permanent in matter, their origin,	62
Protoplasm, pure or primal,	40
—— differentiated or chemical,	140
Radiolaria, theory of their forms,	25
Reason, its origin,	43
Recurrent numbers in organisms,	30, 121
Religion, a normal element in humanity,	43
Respiration, the fundamental function,	79
—— cosmical,	76
—— precluded in the action of the material element itself,	76
Remembrance, its nature,	43
Reversion, its origin,	45
Rocks, primarily exuvial, afterwards igneous,	85
Segmentation of ova, &c., its cause,	93
Sex, its probable origin,	96
Silicium, its structure and genesis,	170
Snow flakes, their form and its cause,	163
Somites, their normal number and its cause,	31, 130
Soul, its birth and growth,	175
Species, why so persistent,	42
Spermatozoids, their origin,	24

